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ABSTRACT

This report describes the status of marine career education in the United States as of July 1975. The objectives of this work are: (1) to assess the current and future manpower needs, (2) to determine the extent of curriculum offerings, (3) to report the availability of relevant materials, (4) to describe the need for new program offerings, (5) to determine materials that need to be developed, (6) to identify the most significant issues, (7) to cluster the key occupations and places of employment, and (8) to prepare guidelines for future curriculum development in the area of marine education. In a concluding section, the research team summarizes findings and recommends courses of action. The group cites as areas of greatest urgency the need to (1) establish interagency coordination for the development of marine career education, and (2) sponsor a comprehensive marine occupational analysis. (Author/CP)

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MARINE EDUCATION:

GUIDELINES FOR CURRICULUM DEVELOPMENT

FINAL REPORT

JUNE 1975

Olympus Research Corporation

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GUIDELINES FOR CURRICULUM DEVELOPMENT

Final Report
June 1975

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INTRODUCTION

The American Bicentennial provides a frame of reference for reviewing the past, present and future role of the United States and its stake in the marine environment. In the first 150 years of the Nation's history, it was a period of continuous westward migration. By the beginning of the twentieth century, the population was dispersed across the heartlands from the Atlantic to the Gulf and Pacific Coast. Folkways, mores, and the way most Americans viewed the world was influenced by a social, economic and political fabric that was fundamentally agrarian. Fifty years ago, or in the mid-nineteen twenties, a second population shift began, this time with movement out of middle America toward the country's major coastal zone. Since 1950 this shift grew dramatically so that today (1975), more than 125 million Americans live less than a day's drive from the seashore. The institutions, attitudes,and values of a land based society have not yet adjusted to this new marine frontier. The impact has been enormous, and each year it grows more critical. There is increasing evidence of serious economic, cultural and political strain on existing social institutions. Not the least important is education and the formal institutions we have established to prepare people for careers and employment. How have the schools responded to these changing economic and social conditions? What should be their role in future years?

Both questions are relevant to all levels and fields of education, but they are of critical importance to Career Education.

PURPOSE AND ORGANIZATION

This report describes the status of Marine Career Education in the United States as of July 1, 1975. The work undertaken to prepare this report was supported by the U.S. Office of Education. The purpose of the study and the report is to provide USOE's Bureau of Adult Vocational and Technical Education a documentary basis for future curriculum decisions. This "State of the Art" study of Marine Education had eight objectives:

- Assess the current and future manpower situation
- Determine extent of curriculum offerings
- Report the availability of relevant materials
- Describe the need for new program offerings
- Determine materials that need to be developed
- Identify the most significant issues
- Cluster the key occupations and places of employment
- Prepare guidelines for future curriculum development

The project was conducted within the conceptual framework of Career Education and a brief overview of this concept is provided as the first "Chapter" of this report. This is followed by a discussion of the cluster concept and a description of the Marine Occupational Cluster.

Marine industries and marine occupations are defined in the manpower section. Marine employment by industry and major occupational family is then reported for 1975 and projected for 1980, which also is done separately and in more detail for each of 19 employment settings. The manpower analysis utilizes various marine industry sources, and includes considerable data obtained from the U.S. Department of Labor. The analysis and methodology have been reviewed by labor economists and manpower specialists in and out of government, as well as persons familiar with specialized marine employment settings. The methodology used in preparing this report is described in some detail, as are important economic, legislative, and occupational factors affecting marine employment.

Following the section on employment, two chapters report on the extent of current Marine Education programs and materials. This analysis of current Marine Education efforts provides the information necessary to propose guidelines for future curriculum development.

A set of twelve significant topics have been identified and described in a separate section under the title "Current Issues Related to Marine Occupational Performance".

The final section, the "guidelines", discusses the essential elements required for effective curriculum development. Suggestions are organized by Career Education phase, specifying goals and objectives.

A summary and specific recommendations complete the report.

To facilitate ease in reading this report, footnotes and references are listed following each section. Appendices are offered to clarify and more fully elaborate certain discussions in the body of the report.

CAREER EDUCATION - WHAT IT IS

Career Education is one positive response by educators to the need to make education more relevant to the life requirements of students. It is concerned with the world of work - all kinds of work - and the preparation of people for work they choose to do. The idea underlying Career Education is that in order to choose and succeed in an appropriate career one should experience four phases, or steps, bringing one to that career:

- awareness of the available career options
- orientation to a variety of employment fields
- exploration of an occupational family having reasonable opportunity for employment
- preparation in job skills for at least entry level positions

What is unique to Career Education is the idea that occupational competence is the result of this four step process, with three of the steps occurring prior to undertaking instruction in specific job skills.

Careers can be thought of as belonging to certain occupational families. Only certain occupations within each family are commonly found at the entry level, and each entry level job has particular performance requirements job applicants are expected to meet. Instructional programs preparing for entry level occupations must therefore have a focus that approaches specialization.

However, the need for specialized training reduces the number of occupational options one can pursue simultaneously, and consequently, occupational choice becomes a critical decision point in the career development process. While there is a certain amount of occupational mobility in the U.S. economy, the costs to both the individual and society of preparing for a specific occupation are often so high as to make change from that occupation relatively difficult. Therefore, it is important that individuals make wise vocational choices, and the pre-vocational steps of awareness, orientation, and exploration can provide the information and experience necessary to do this.

AWARENESS

Career Education at the Awareness phase introduces students to a number of worlds of work. Each world is broadly defined, such as the health, construction, transportation, and marine career fields.

Awareness activities usually begin in the early grades (K-6) and complement existing curriculum. Relevant career topics and issues are introduced in social studies or language arts. Students are made aware of relationships and interdependency of one industry to another. Work values are examined and students begin to develop skills of self-assessment in terms of interest relative to the life style of different career fields.

ORIENTATION

This second phase provides experiences aimed at moving from the global view work setting to an examination of sub-fields. For example, the world of marine careers can be divided into five sub-fields: Recreation, Science, Resources, Technology and Maritime.

Specific employment settings may be examined, along with the relationships betweem them and other career fields. This phase can begin in the upper elementary grades and continue into the middle school grades. One objective of this phase is that the student begins the career decision process.

Following an orientation to the life style, working conditions, and career opportunities available in each marine sub-field, students can be encouraged to examine their own interest and aptitudes in relation to what they have observed in relevant marine careers.

EXPLORATION

Hands-on experience and work simulation are central to this phase of the career development process. While the first two phases are chiefly concerned with examining employment settings, the exploration phase begins to focus on occupational families.

This phase can begin as early as junior high school (grade seven) or be introduced in the early high school grades. Learning activities utilize tools, materials, and techniques commonly associated with the occupational families that belong to particular career fields. For example, units of instruction in mathematics make use of the tools of measurement common to particular occupational families. Similar cross discipline planning can directly relate science, health or literature units to relevant career fields. A key objective of this phase is to help individuals integrate work values with their personal value system. One learns to make decisions by making them. The final objective of the exploration phase should aid students in making decisions concerning what occupation or occupational family they will select. If the occupation requires college level preparation, they have made a major career decision. If it requires the skills and training that can be acquired in high school, preparation can begin immediately.

PREPARATION

Preparation programs leading to entry level employment must provide the skills employers require for initial placement. This phase can, for most occupations, take place in grades 11 to 14, since less than 20 percent of U.S. jobs require a four year college degree. School-based preparation programs, if they are to be successful, must closely replicate the actual work setting. Employers and trade union representatives have provided much of the expertise needed to bring preparation programs up to industry requirements.

This four step process is intended to move from a general level of understanding of the world of work to specific performance in an entry level occupation. This is a process that most individuals will experience more than once, indeed, whenever they are faced with making occupational choices. Career Education can aid in this process and is appropriate for all students at all educational levels.

An effective Career Education curriculum will integrate the elements and objectives of all of education, stressing those that contribute to career success. What is called for in Career Education is cross-discipline planning between existing curriculum, such as math, science, social studies, language arts, and occupational specialities. It also demands the active involvement of the total community of which the school is a part. The result of this process is a learning environment that the student perceives as more relevant and which encourages the student to begin acquiring the skills required to select and prepare for a meaningful career. The following chart shows how the four phases of Career Education can contribute to the career development process.

CAREER DEVELOPMENT PROCESS

Typical Grade Levels	
K-6	Awareness to many different worlds of work including value systems, life styles, self assessment process.
6-8	Orientation of selected employment settings and working conditions with early emphasis on developing career decision making skills.
7-9	Exploration of one or more occupational clusters through "hands on learning experience" leading to selecting a field for preparation.
10-14	Preparation leading to entry level employment or advanced education and training in a particular career field.

THE REVISED MARINE OCCUPATIONAL CLUSTER

Central to the career education process is the eventual goal of entering the job market. Education should enhance a person's ability to choose and prepare for a particular career field. A premature decision can lead to job dissatisfaction and low productivity. If they are to make wise career decisions, students must be aware of the range of job opportunities and of the training and performance requirements for jobs in which they are interested. Because there are many thousands of different kinds of jobs, it is necessary that students have the means to sort out and examine relevant job opportunities in some efficient way. One means to aid students in this examination is the occupational cluster.

The marine field is one of fifteen occupational clusters developed by the U.S. Office of Education (USOE) to describe, in broad terms, the world of work. Each cluster is made up of both occupational specialities and places of potential employment. The cluster approach provides students, parents, and teachers a manageable way of viewing potential career fields. The official fifteen cluster fields include, in addition to Marine, the following:

Agri-Business and Natural Resources
Business and Office
Communications and Media
Construction
Consumer and Homemaking
Environmental
Fine Arts and Humanities
Health
Hospitality and Recreation
Manufacturing
Marketing and Distribution
Personal Service
Public Service
Transportation

"Marine Science" was the title originally used by USOE to describe the occupational cluster. The word "science" proved to be overly restrictive and misleading in describing the overall marine field. Therefore, the term "marine science" was deleted as the cluster title and used to define one of the marine occupational cluster sub-fields.

Over time, the composition of a particular cluster is subject to change in structure and content. Such changes should be made as information becomes available suggesting that new occupations have emerged, new industries have been established, or older industries have contracted to the point that employment levels and certain key occupations are no longer significant.

In the final analysis, the concept of clustering is based on the need for a manageable method to describe those occupations and places of employment that can be logically grouped together. While one can find nurses in factories, shipyards, and recreational facilities, it is easy to see why nurses belong to the Health Occupations Cluster. On the other hand, carpenters may be employed in hospitals, on ships, and in school buildings, but there is no difficulty grouping all 1.1 million carpenters employed in the United States under the Construction Cluster. This suggests that it is possible to group together, or cluster, occupations into job families of closely related fields of employment.

The cluster also provides a mechanism for describing employment and occupational detail at two levels. Employment can be described by sub-field and employment setting (employing establishment). Occupations can be grouped by job family and occupational specialty. The Marine Cluster is made up of five sub-fields and 19 employment settings. The available data has made it possible to describe 15 marine occupational families.

More than 200 different marine job specialties have been identified in the Dictionary of Occupational Titles (DOT). Lacking a precise measure of job content and a description of the commonalities that exist among marine occupations, it has not been possible to assign the 200 plus job specialties to the 15 marine occupational families. To perform this task, a special marine occupational analysis will be required. This is the next logical step in the development of the marine cluster. But a great deal of curriculum planning and instructional materials development can take place with the occupational material now available. For all but the preparation phase of Career Education, a description of occupational families is sufficient to begin the design of programs.

The title "Seaman" is an example of a marine occupational family. The ship's Captain (Master) and the 40 other persons employed on a typical U.S. freighter (displayed below) are all Merchant Seamen, just as are the pilot, deckforce and engine crew of an inland tugboat operating on the Mississippi River.

MANNING SCHEDULE OF A TYPICAL U.S. MERCHANT FREIGHTER

MASTER
First Mate
Second Mate
Third Mate
Jr. Third Mate

Boatswain
Carpenter
2 Deck Maintenance
3 Able Seamen

3 Ordinary Seamen

CHIEF ENGINEER
First Asst. Engineer
Second Asst. Engineer
Third Asst. Engineer
Jr. Third Asst. Engineer

Electrician
Second Electrician
Refrigeration Engineer

3 oilers
3 Firemen/Watertenders
3 Wipers

Radio Operator

Purser

Steward
First Cook
Second Cook and Baker

2 Saloon Messmen
2 Crew Messmen

There is certainly sufficient information available to design programs that could focus on the career development of Seamen.

In designing the revised Marine Occupations Cluster, the experience of a sister project was utilized. The Public Service Occupations Cluster identified four criteria that were utilized in designing the marine occupations cluster. To be included as part of an occupational cluster, the following criteria would apply:

- The job family had a favorable employment outlook
- The job family contained jobs at paraprofessional, professional, skilled and semi-skilled levels
- Jobs in the family had some opportunity for employment in various sections of the country
- Jobs in the family were a part of a reasonably well-defined career lattice

The staff of the Marine Occupations Cluster project added a fifth criterion:

- Occupations selected for a particular cluster should contain a set of common skills unique to the specific field of employment

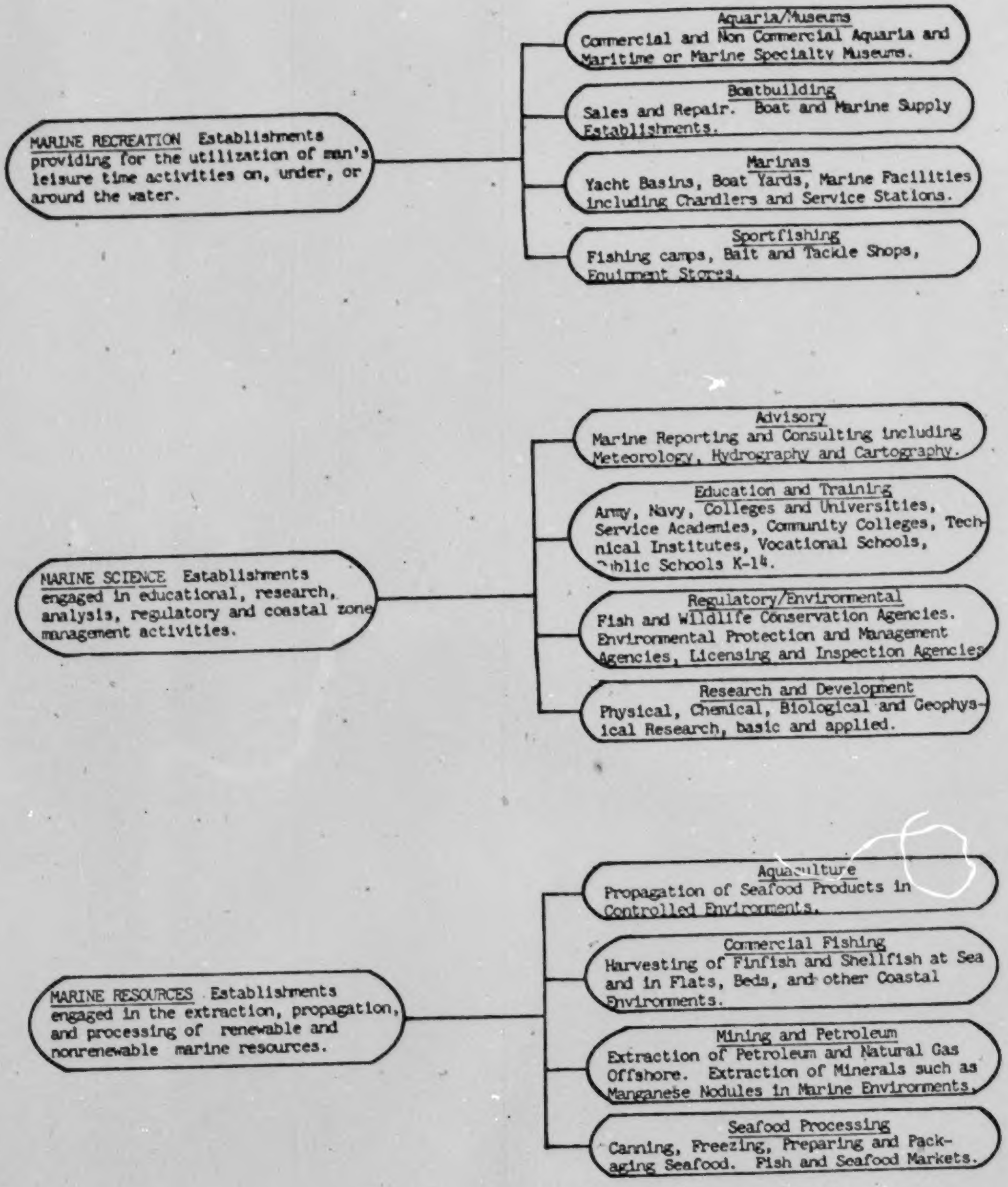
This fifth criterion establishes a foundation for identifying common core competencies, and occupational competency is what Career Education is all about. To identify specific skills required for each occupational specialty, it is necessary to begin with detailed tasks analysis of each relevant marine occupation. Such analysis was beyond the scope of the present study. Nevertheless, the new Marine Cluster provides a comprehensive and valid framework for conducting more detailed analysis as task performance statements are developed through subsequent research.

The Marine Occupational Cluster is displayed on the fold-out that follows. The cluster is composed of five major sub-fields, nineteen employment settings, and fifteen occupational families. The nineteen employment settings finally selected represent the most logical grouping and reduction of more than 200 Standard Industrial Classifications (SIC's) judged relevant to the marine field.

In designing the structure and deciding on the composition of a particular cluster, it is almost inevitable that certain occupations will fall into multiple clusters. In selecting occupations and employment settings, one question must remain paramount. How many different occupations and employment settings can a student be expected to conceptualize at one time? The very best one can do is to search for unique sets of skills that identify occupations with closely related job families and attempt to match these job families to well-defined and easily-described employment settings.

Professional judgements were made as to what occupations and employment settings belong the the Marine Cluster. Such decisions were based on available manpower data, the advice of employers, and the expert opinion of persons closely related to those establishments that make up the marine industry.

MARINE OCCUPATIONS CLUSTER



MAJOR SUB FIELD

EMPLOYMENT SETTING

MARINE RECREATION Establishments providing for the utilization of man's leisure time activities on, under, or around the water.

- Aquaria/Museums
  Commercial and Non Commercial Aquaria and Maritime or Marine Specialty Museums.
- Boatbuilding
  Sales and Repair. Boat and Marine Supply Establishments.
- Marinas
  Yacht Basins, Boat Yards, Marine Facilities including Chandlers and Service Stations.
- Sportfishing
  Fishing camps, Bait and Tackle Shops, Equipment Stores.

MARINE SCIENCE Establishments engaged in educational, research, analysis, regulatory and coastal zone management activities.

- Advisory
  Marine Reporting and Consulting including Meteorology, Hydrography and Cartography.
- Education and Training
  Army, Navy, Colleges and Universities, Service Academies, Community Colleges, Technical Institutes, Vocational Schools, Public Schools K-14.
- Regulatory/Environmental
  Fish and Wildlife Conservation Agencies. Environmental Protection and Management Agencies, Licensing and Inspection Agencies
- Research and Development
  Physical, Chemical, Biological and Geophysical Research, basic and applied.

MARINE RESOURCES Establishments engaged in the extraction, propagation, and processing of renewable and nonrenewable marine resources.

- Aquaculture
  Propagation of Seafood Products in Controlled Environments.
- Commercial Fishing
  Harvesting of Finfish and Shellfish at Sea and in Flats, Beds, and other Coastal Environments.
- Mining and Petroleum
  Extraction of Petroleum and Natural Gas Offshore. Extraction of Minerals such as Manganese Nodules in Marine Environments.
- Seafood Processing
  Canning, Freezing, Preparing and Packaging Seafood. Fish and Seafood Markets.

MARINE OCCUPATIONAL FAMILIES

SCIENTIFIC personnel including oceanographers, meteorologists and all those physical, biological, behavioral and social scientists who specialize in marine research, development, planning, regulatory and advisory services.

ENGINEERING specialties primarily concerned with the design, construction, inspection, and maintenance of marine installations, equipment, platforms machinery, ocean systems and facilities used in a marine environment.

TECHNICAL. Para-professional personnel in science, engineering and related supportive roles who usually require two years of post-secondary education or equivalent on-the-job training.

MANAGERIAL positions chiefly responsible for directing the operation of specialized marine proprietorships including marinas and yacht clubs.

COMMUNICATIONS personnel who specialize in marine fields such as cartographers, weathermen, radio and similar marine electronics operators, marine writers and journalists.

SUPPORTIVE specialized personnel who provide fiscal, legal, accounting, clerical and other support services to the marine business environment.

SALES persons including yacht brokers, ships chandlers, marine surveyors and similar marine sales specialties in both wholesale and retailing.

ELECTRICAL crafts including marine electricians and electronics specialists who install, maintain and repair special marine electrical equipment and instruments.

FITTERS, shipfitters, machinists, and other metal working craftsmen and semi-skilled metal working occupations such as welders who fabricate, maintain and repair marine vessels and equipment that meet Coast Guard, Maritime and other Federal certification requirements for operation or installation in or on navigable waters.

CRAFTSMEN, shipwrights, boatbuilders and repairmen who work in woods and new synthetic materials, also other marine craftsmen not listed under electrical, fitters, and mechanics.

MECHANICS who install, repair and maintain propulsion systems management activities.

- Environmental Protection and Management Agencies, Licensing and Inspection Agencies
- Research and Development
  Physical, Chemical, Biological and Geophysical Research, basic and applied.

MARINE RESOURCES Establishments engaged in the extraction, propagation, and processing of renewable and nonrenewable marine resources.

- Aquaculture
  Propagation of Seafood Products in Controlled Environments.
- Commercial Fishing
  Harvesting of Finfish and Shellfish at Sea and in Flats, Beds, and other Coastal Environments.
- Mining and Petroleum
  Extraction of Petroleum and Natural Gas Offshore. Extraction of Minerals such as Manganese Nodules in Marine Environments.
- Seafood Processing
  Canning, Freezing, Preparing and Packaging Seafood. Fish and Seafood Markets.

MARINE TECHNOLOGY Establishments engaged in the design, planning, fabrication, construction and contracting of ships platforms and terminal facilities.

- Marine Construction
  Breakwater, Channel, Canal, Pier and Harbor Construction.
- Waterway & Ocean Engineering
  All Marine Engineering on Inland Waterways, Great Lakes and Oceans, Drafting and Surveying. Naval Architecture. Offshore Oil and Gas Field Exploration Service. Nautical and Navigational Instruments Service.
- Shipbuilding and Repair
  Ship Painting, Ship Joinery, Ship Boiler and Tank Cleaning and Repair. Ship Scaling, Marine Salvaging and Wrecking.

MARITIME OPERATIONS Establishments engaged in domestic and foreign ship, boat and barge operation, cargo handling, and terminal operations.

- Merchant Marine
  Deep Sea and Coastwise Ship and Barge Operations.
- Inland Operations
  Great Lakes, Inland Waterways, Canal and Harbor Transportation. Ferrying Ship, Tug and Barge Operations.
- Port and Harbor
  Marine Cargo Handling, Stevedoring, Terminal Operation, Piloting Services, Towing and Undocking, and related Tugboat Operations.
- Offshore Support
  Offshore Oil and Gas Services, Tug/Supply Vessels, Personnel Carriers, Rig Transport.

such as cartographers, weathermen, radio and similar marine electronics operators, marine writers and journalists.

SUPPORTIVE specialized personnel who provide fiscal, legal, accounting, clerical and other support services to the marine business environment.

SALES persons including yacht brokers, ships chandlers, marine surveyors and similar marine sales specialties in both wholesale and retailing.

ELECTRICAL crafts including marine electricians and electronics specialists who install, maintain and repair special marine electrical equipment and instruments.

FITTERS, shipfitters, machinists, and other metal working craftsmen and semi-skilled metal working occupations such as welders who fabricate, maintain and repair marine vessels and equipment that meet Coast Guard, Maritime and other Federal certification requirements for operation or installation in or on navigable waters.

CRAFTSMEN, shipwrights, boatbuilders and repairmen who work in woods and new synthetic materials, also other marine craftsmen not listed under electrical, fitters, and mechanics.

MECHANICS who install, repair and maintain propulsion systems including gasoline, diesel and steam engines as well as hydraulic, pneumatic and refrigeration systems.

SEAMEN. All who commercially operate boats and ships on any navigable waterway including deck, engine and steward department personnel.

LONGSHORE. The support services in a port including stevedores, equipment operators and clerks directly responsible for the loading and unloading of merchant vessels of any type.

FISHERMEN. All those occupations encompassing the harvesting and processing of food from the sea as well as the propagation, rearing and harvesting in hatcheries and fish farms.

LABORERS. Fish processors and packers, yard workers, marina attendants, and all those occupations that do not require extensive formal training.

NOTE: These occupational families are not necessarily exclusive to a single Career Subfield or a single Employment Setting.

MANPOWER ANALYSIS

Current economics grant to human resources the primacy once reserved for natural and capital resources alone. International competition and internal prosperity have demanded evolving scientific development, a high level of technical competence, and increasingly trained manpower. Economic and social changes putting a premium on the quality of the human resource contribution have impacted both ends of the manpower spectrum. More and more, it is only one's own talents and skills which determine one's place in the economic scheme of things; human resources are in fact becoming the wealth of nations. The marine manpower situation in itself exemplifies the constant and rapid change which is occurring in the economic and social considerations of human resources in our nation.

DEFINING MARINE INDUSTRIES

In order to address the manpower situation in the marine economy, the project team arrived at the following definition of a marine industry:

> A marine industry is one that has as its primary purpose providing a service or product for use on or under the water or contiguous land bodies (shorelines), and employs workers who have special knowledge and training to successfully perform tasks that are unique to the marine environment.

Using this definition as a starting point, four additional criteria were established to select the specific industries to be considered as marine employers. The criteria are:

- The industry is national and not limited to a single regional market;
- Approximately one-third or more of employment in the industry is made up of workers who possess marine-based occupational skills;

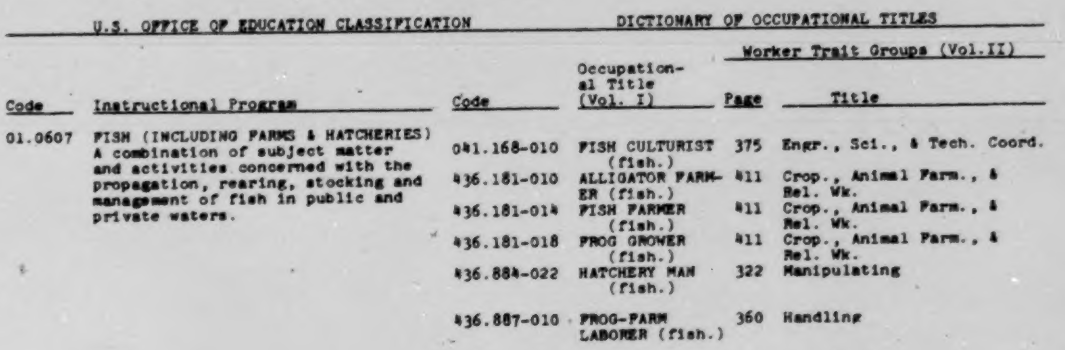
- The industry has at least one national trade association or national labor union devoted exclusively to the marine interest of the member firms or individual union members;
- There exists, at the national level, a professional society or an educational organization having as its central purpose the improvement or advancement and well-being of a particular marine industry.

Using the definition and each criterion, it was possible to identify nineteen distinct and significant types of marine industry employing establishments. These nineteen types were grouped into five major "sub-field" categories: Recreation, Resources, Science, Technology, and Maritime Operations. Having in hand a workable definition of marine industries, the next step called for defining a marine occupation.

DEFINING MARINE OCCUPATIONS

An industry or place of employment describes where one works. An occupation describes what one does at one's place of work. There are at least three major documents chiefly concerned with occupations - The Dictionary of Occupational Titles (DOT), the Occupational Outlook Handbook, and the USOE's Vocational Education and Occupations. In addition, there are census publications that utilize special descriptions of occupations. The Office of Management and Budget also is currently developing a manual that will establish a Standard Occupational Classification System to complement the Standard Industrial Classification (SIC) manual.

It is possible to identify in detail 35,000 specific occupational titles recorded in Civil Service, Military, Census, and Labor Department publications. Even the 22,000 specific titles found in the DOT are beyond a single person's comprehension. In an effort to bring some order to the task of organizing detailed occupational information into a form for use by educational planners, in 1969, the U.S. Office of Education published Vocational Education and Occupations. This single volume (currently being revised and updated) groups 6,000 DOT level occupations according to 400 instructional program titles. It can be seen in the photo reduction of one page from the USOE publication, how one Instructional Program provides a focus for six different but related occupational specialties.



U.S. OFFICE OF EDUCATION CLASSIFICATION		DICTIONARY OF OCCUPATIONAL TITLES			
				Worker Trait Groups (Vol.II)	
Code	Instructional Program	Code	Occupational Title (Vol. I)	Page	Title
01.0607	FISH (INCLUDING FARMS & HATCHERIES) A combination of subject matter and activities concerned with the propagation, rearing, stocking and management of fish in public and private waters.	041.168-010	FISH CULTURIST (fish.)	375	Engr., Sci., & Tech. Coord.
		436.181-010	ALLIGATOR FARMER (fish.)	411	Crop., Animal Farm., & Rel. Wk.
		436.181-014	FISH FARMER (fish.)	411	Crop., Animal Farm., & Rel. Wk.
		436.181-018	FROG GROWER (fish.)	411	Crop., Animal Farm., & Rel. Wk.
		436.884-022	HATCHERY MAN (fish.)	322	Manipulating
		436.887-010	FROG-FARM LABORER (fish.)	360	Handling

The need for this simplifying approach is based on the reality that no single school or college could begin to train future workers separately for entry-level job openings in thousands of specialized occupational titles. The USOE approach offers students the opportunity for multiple job options. These multiple options are necessary to avoid saturating single occupational specialities. However, in order to develop instructional program descriptions and course content for multiple option programs, it is necessary to have available for detailed analysis all of those occupations sharing a common core of skills and competencies.

In the project search for information about marine occupations, five major sources of occupational descriptions were examined for their relevance to the marine field. In addition to Labor Department, Census, USOE, and military job description sources, interviews with personnel managers in selected marine industries were conducted in eight major port cities: Boston, New York, Baltimore, Houston, New Orleans, Los Angeles, Seattle, and Chicago. Published and unpublished manpower and labor market studies were also examined for the purpose of pinpointing marine occupational specialties. The final results of nine months of investigation indicated that detailed occupational information exists in very few marine fields. While there are comprehensive reports available on employment levels in marine recreation, shipbuilding, and certain segments of commercial fishing, there is a paucity of specific marine occupational information. As described in the discussion on clustering, the title and descriptions of more than 200 occupational specialties were carefully examined to determine the most manageable way of grouping them for the purposes of this study.

To begin to pinpoint a definition of a marine occupation, it was logical to return to the phrase cited earlier in the definition of a marine industry:

> "...workers who have special knowledge and training to successfully perform tasks that are unique to the marine environment."

Lacking adequate task and content descriptions for a sufficient number of marine occupations, it was not possible to improve on the above cited as a definition for a marine occupation. It was possible, however, to obtain a more operational definition by identifying fifteen marine occupational families that proved compatible with standard U.S. Labor Department reporting classifications. This approach, when combined with the identification of nineteen marine employment settings, made it possible to more precisely define the marine occupational cluster.

SUPPLY CONSIDERATIONS

The supply of labor available to fill any of these marine occupations must come from two sources: internal to the industry or external to it. Internal sources refer to persons already employed in the industry who are promoted or persons who make a lateral move. External sources are new entrants to the marine industry, including persons transferring from another field or persons new to the labor market. A supply/demand analysis of all available marine workers was beyond the scope of this study.

Because the purpose of this study is to serve education, schools deserve special attention as a source of labor supply. Most persons currently in high school (1975) will enter the labor market before 1980. The female workforce participation rate (for persons 18 to 24) in 1975 is 60 percent versus 85 percent for males. Secondary school enrollments in 1975 exceed 15 million persons. Over three million persons graduate each year from high school, and of this number, about two-thirds flow directly into the labor market.

How many students are currently enrolled in programs preparing them for employment in marine occupations? These enrollment levels are reported in the following table:

VOCATIONAL EDUCATION ENROLLMENT (SECONDARY)	5,900,000
Enrollment in Maritime Occupations	1,233
Enrollment in Oceanographic Technology	270
Enrollment in Commercial Fishery Occupations	206
TOTAL Marine Enrollment	1,709
POST-SECONDARY ENROLLMENT (Grades 13 and 14)	1,400,000
Enrollment in Maritime Occupations	512
Enrollment in Oceanographic Technology	1,735
Enrollment in Commercial Fishery Occupations	430
TOTAL Marine Enrollment	2,677

SOURCE: U.S. Office of Education, Division of Vocational and Technical Education (1973).

A recent study, supported by NOAA, reports that in 1974, 1,602 students were enrolled in 35 two-year post-secondary marine technician training programs, suggesting some consistency in the data sources.

Regardless of growth in marine employment, job vacancies constantly occur as a result of normal attrition, which includes those persons who leave the industry from death, retirement, or any other reason for separation. For most of U.S. industry, attrition rates approximate 5 percent. If this figure is applied to marine employment, about 125,000 job openings should occur annually in addition to 60,000 new jobs each year due to growth. It is obvious that the graduates of formal marine employment preparation programs do not begin to supply the workers needed to meet even the replacement requirements, let alone those needed due to industrial growth.

FACTORS AFFECTING EMPLOYMENT LEVELS

Employment is affected by numerous political, social, and economic factors, including investments, consumer demand, technology, and world trade. In politics, nation states wrestling with international issues ranging from laws of the sea to defense and energy discover the impact of decisions on job creation and manpower training. Manpower trends cannot be understood and charted without recognizing these influences.

For that reason, this report focuses on the impact of political and economic trends on five major marine employment sub-fields. Within the five sub-fields, 19 employment settings have been identified. Preceding each employment setting description are employment data for 1970, 1975 and projections for 1980. At the end of the manpower methodology section, matrices display marine industry employment for 1975 and projected to 1980 by major occupational families, thus providing a quick overview of the patterns according to which marine workers are distributed.

Legislation and regulations are vital factors in shaping the kind and extent of opportunity in marine-related industries and occupations. Therefore, they are important subjects for investigation. The project reviewed existing and pending legislation in each of the nineteen marine employment settings and fourteen occupational families in order to assess current and projected employment opportunities.

In most of the established marine industries, legislation is extensive and comprehensive, and over 200 items of current and pending law were examined in order to pinpoint the legal forces shaping economic decisions.

Of these, 35 laws were identified as having highly significant impact on marine manpower. A few examples are in order.

In 1790, Congress mandated that fishermen who directly land their catch in the United States use only vessels which were built in this country. This law was logical since fishermen could utilize the winter months to build their own craft. Today, however, many United States fishermen would prefer to purchase their craft from foreign boat yards where the prices are lower than in the U.S. Therefore, they are seeking a change in the 1790 law. Many fishermen also are seeking the extension of United States terriorial waters to 200 miles out to sea so as to protect fishing grounds upon which American fishermen depend. Considerable evidence suggests the 200 mile limit will ultimately become law; on the other hand, the 1790 "Buy American" laws for vessels for commercial use may remain on the books and even be extended to other forms of United States marine enterprises.

Much legislation enacted in non-marine fields strongly affects marine industries. The new environmental legislation is a case in point. All new marine recreation craft must install special holding tanks as toilet facilities so as not to discharge waste into open waters. Another case in point related to new Federal Communication Commission rules requires all radio communication using marine frequencies to utilize VHF equipment as of January 1976. Beginning in 1977, only single sideband MF (medium frequency) sets will be allowed to operate in the 203 MHz band. Until 1977, however, boats with existing double sideband MF equipment can replace it with similar equipment, as long as the boat remains in the possession of the owner to whom the license for the existing radiotelephone was issued, and the new set is installed before the expiration of that license. This seemingly insignificant regulation will have great impact on all persons who are employed to sell, install, maintain and repair millions of units of marine communications equipment. The FCC is a regulatory agency but its decisions have the effect of law and therefore directly influence the demand for labor.

Once the legislative process is completed, governmental administrative and regulatory agencies become the central actors in applying the force of law, for it is the mission of the Executive Branch through specialized government agencies to implement and monitor laws created by legislatures. The project found no single authoritative source documenting the full extent to which federal and state government agencies are responsible for facets of the marine industry. In their 1969 document, Our Nation and the Sea, the Commission on Marine Science, Engineering and Resources attempt to identify and describe federal agencies having a marine jurisdiction. They report the difficulty to identify such responsibility and authority in each facet of marine activity. Part of the problem lies with overlapping jurisdictions in Congress. In 1970, the National Oceanic and Atmospheric Administration (NOAA) was formed in an effort to bring together a number of marine-oriented agencies within the Department of Commerce. Yet, more government agencies with marine involvement exist outside of NOAA and the Department of Commerce than inside.

The project team identified so many Federal and state agencies having responsibility for a marine-based activity that it proved impossible to assess the potential influence each agency exerts separately on the demand for marine manpower. An example of this complexity can be seen in a description of six agencies that commonly work together to maintain safe maritime conditions. Every hour on the hour, in every coastal region of the country, the Marine Division of the United States Weather Service broadcasts weather reports to mariners. A small storm on shore causes the normal flow of a river to deposit silt in a new location. The Army Corps of Engineers, through frequent surveys, notes the change and recommends to the Coast Guard that they move a buoy (channel marker) to a new location. The Coast Guard, after making this change, notifies the local telephone company, the Defense Mapping Agency, the Hydrographic Office of the Navy and the United States Coast and Geodetic Survey Office.

Five times per day the telephone company broadcasts a "Notice to Mariners" indicating the change of buoy location. The Navy Hydrographer makes the change in all military charts. The U.S. Coast and Geodetic Survey cartographers indicate the change in all new charts used in recreational and commercial navigation. The Coast Guard also reports the change in its weekly publication, Local Notice to Mariners, mailed each Wednesday to all subscribers.

The next merchant ship to pass this location safely moves up the channel avoiding a situation that could have proved hazardous. It would be difficult to calculate the manpower involved in this marine activity, but it is illustrative of the critical cooperation needed from agencies of three different departments: Commerce, Defense, and Transportation.

Governmental action and legislation greatly influence the economic climate for private industry. The decision to build a modern Navy is sometimes said to have done more than anything else for the development of the American steel industry and the large labor force it employs. Economic forces such as variations in supply and demand or the rise of new technologies can have even greater effects on industry. New technologies stimulated by world demand for more energy sources is a case in point. A work stoppage in one basic industry can quickly compound into widespread disruptions or layoffs through an entire economy. This means that employment characteristics of various careers, among them the marine-related occupations, should be assessed in the context of the general economy in which they are embedded.

Perhaps the most fundamental contextual information has to do with the relative definition and size of the various industries and occupations comprising the American economic structure. This entails developing categories into which all U.S. industries can be grouped, describing the employment characteristics of each industrial category. Occupations are similarly grouped and described. This information illumines the relative size and importance of the various labor markets, of which the marine occupations are an important and significant part. The Marine Careers project produced such a contextual analysis of the total U.S. and marine-related employment. The following section summarizes the methodology used in obtaining the estimates to follow.

METHODOLOGY FOLLOWED IN CONDUCTING THE MANPOWER STUDY

The principal purpose of the manpower investigation was to determine where marine-related jobs are located and who fills them. Many sources were consulted in order to identify the data and methods most appropriate to this purpose. However, it was found that conventional manpower data, as collected and presented by private and public agencies concerned with occupational statistics, do not easily lend themselves to the kind of career clustering basic to the Marine Careers project. Therefore, it was necessary to develop a methodology to transform available data into manageable information suitable for estimating employment opportunities in terms of the U.S.O.E. clusters.

THE U.S. EMPLOYMENT MATRIX

In order to relate marine employment to the national employment picture, it is necessary to understand something about how U.S. employment is distributed. It was decided that this distribution is most clearly perceived within the framework of an employment matrix, which can be read from the viewpoints both of where jobs are located (employment by industry) and of who fills the jobs (employment by occupational classification). In such a table, complex information can be condensed to a few categories easy to understand and remember. Table 1 presents the universe of U.S. employment in this form, providing a summary of the world of work at a glance. The following discussion describes the sources of the data components going into this matrix.

Employment by Industry: Where the Jobs Are

The Office of Management and Budget publishes a classification of industries, in which the over one million employing establishments are fitted into about 16,000 coded categories of industries. Using the Standard Industrial Classification system (SIC), the total U.S. employment can be distributed under the eleven titles displayed across the top of Table 1:

Agriculture (including Forestry, Fisheries, Nurseries)
Mining (including Oil Extraction)
Construction
Manufacturing (Durable, Non-durable)
Transportation, Communication, Public Utilities
Trade (Wholesale, Retail)
Finance, Insurance, Real Estate
Health
Education
Other Services (Personal, Business, Legal, Lodging, etc.)
Public Administration

Employment by Occupation: Who Fills the Jobs

There are two occupational classification systems which are more or less similar: (1) the Dictionary of Occupational Titles(D.O.T.), which codes occupations into about 22,000 titles with details on skills involved in each occupation; and (2) the Census system, which uses a more manageable breakdown of about 450 occupations in twelve major groups. Drawing from the categories in these systems, occupations can be grouped into nine headings, as displayed on the left side of the Table 1 matrix.

Professional and Technical
Managers and Administrators
Clerical
Sales Workers
Craftsmen (skilled)
Operatives (semi-skilled)
Service Workers
Laborers
Farm Workers

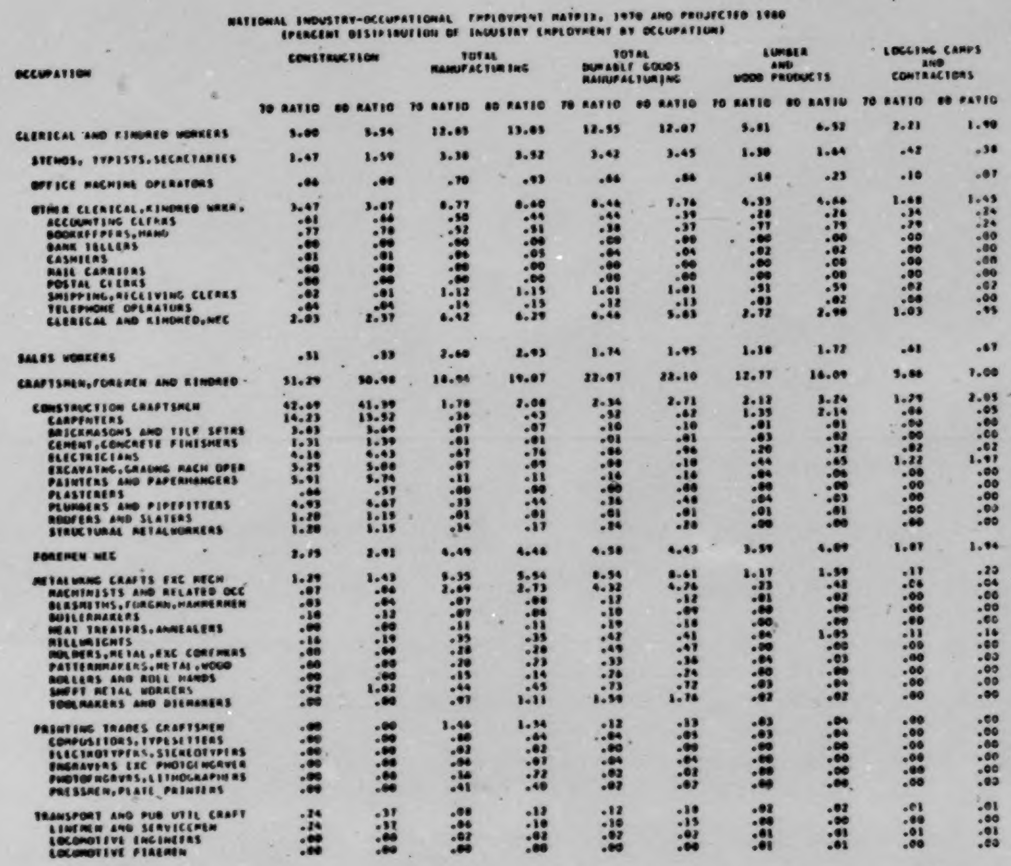
U.S. EMPLOYMENT DISTRIBUTION BY INDUSTRY, BY OCCUPATION (1975)
(in thousands)

	Total Employment	Agriculture	Mining	Construction	Manufacturing	Transportation Communications Public Utilities	Wholesale, Retail Trade	Finance Insurance Real Estate	Health	Education	Other Services	Public Administration
	thousands											
TOTAL	86,800	3,300	600	5,300	21,000	5,300	17,100	4,100	5,400	7,600	12,100	5,000
Professional Technical	13,330	80	60	340	2,230	400	420	150	2,000	4,650	2,120	880
Managers	8,890	30	60	530	1,290	420	3,490	930	120	280	1,260	480
Clerical	15,450	40	70	280	2,720	1,320	3,040	1,920	920	1,130	2,010	2,000
Sales	5,290	10	10	20	580	60	3,680	770	0	10	150	0
Craftsmen	11,200	40	160	2,710	3,990	1,150	1,360	70	120	230	970	400
Operatives	14,720	110	230	520	9,030	1,330	2,130	20	100	140	960	150
Service Workers	11,370	10	10	20	280	160	2,270	190	2,120	1,100	4,290	920
Laborers	3,730	160	0	880	880	460	710	50	20	60	340	170
Farm Workers	2,820	2,820	0	0	0	0	0	0	0	0	0	0

TABLE 1

The Distribution of Employment: Filling the Matrix Cells

The best sources for obtaining the number of persons working in specific occupational groups are from updatings of the U.S. Census. Though the total number of persons employed changes, the distribution of employment by percentage of the total number employed tends to be more stable. The best source for a percentage distribution of U.S. employment for 1970 and projected for 1980 is Tomorrow's Manpower Needs, in its latest revision, produced by the Bureau of Labor Statistics (B.L.S.). This data appears in the format of the following example:



NATIONAL INDUSTRY-OCCUPATIONAL EMPLOYMENT MATRIX, 1970 AND PROJECTED 1980
(PERCENT DISTRIBUTION OF INDUSTRY EMPLOYMENT BY OCCUPATION)

OCCUPATION	CONSTRUCTION		TOTAL MANUFACTURING		TOTAL DURABLE GOODS MANUFACTURING		LUMBER AND WOOD PRODUCTS		LOGGING CAMPS AND CONTRACTORS	
	70 RATIO	80 RATIO	70 RATIO	80 RATIO	70 RATIO	80 RATIO	70 RATIO	80 RATIO	70 RATIO	80 RATIO
CLERICAL AND KINDRED WORKERS	5.00	5.54	12.05	13.05	12.55	12.07	5.81	6.52	2.21	1.90
STENOS, TYPISTS, SECRETARIES	1.47	1.59	3.38	3.52	3.42	3.45	1.30	1.64	.42	.38
OFFICE MACHINE OPERATORS	.06	.08	.70	.93	.66	.86	.18	.23	.10	.07
OTHER CLERICAL, KINDRED WRKR.	3.47	3.87	8.77	8.60	8.46	7.76	4.33	4.66	1.68	1.45
ACCOUNTING CLERKS	.61	.66	.50	.44	.44	.39	.28	.26	.34	.24
BOOKKEEPERS, HAND	.77	.78	.52	.51	.38	.37	.77	.79	.29	.24
BANK TELLERS	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
CASHIERS	.01	.01	.06	.05	.04	.04	.02	.02	.00	.00
MAIL CARRIERS	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
POSTAL CLERKS	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
SHIPPING, RECEIVING CLERKS	.02	.01	1.12	1.15	1.01	1.01	.51	.59	.02	.02
TELEPHONE OPERATORS	.04	.04	.14	.15	.12	.13	.03	.02	.00	.00
CLERICAL AND KINDRED, NEC	2.03	2.37	6.42	6.29	6.46	5.83	2.72	2.90	1.03	.95
SALES WORKERS	.31	.33	2.60	2.93	1.74	1.95	1.10	1.72	.41	.67
CRAFTSMEN, FOREMEN AND KINDRED	51.29	50.98	18.96	19.07	22.07	22.10	12.77	16.09	5.86	7.00
CONSTRUCTION CRAFTSMEN	42.69	41.99	1.78	2.08	2.36	2.71	2.12	3.24	1.29	2.05
CARPENTERS	14.23	13.92	.36	.43	.32	.62	1.35	2.14	.06	.05
BRICKMASONS AND TILE SETRS	3.83	3.69	.07	.07	.10	.10	.01	.01	.00	.00
CEMENT, CONCRETE FINISHERS	1.31	1.39	.01	.01	.01	.01	.03	.02	.00	.00
ELECTRICIANS	4.18	4.43	.67	.76	.86	.96	.20	.32	.02	.02
EXCAVATNG, GRADNG MACH OPER	5.25	5.08	.07	.09	.08	.18	.44	.65	1.22	1.97
PAINTERS AND PAPERHANGERS	5.91	5.74	.11	.11	.16	.16	.04	.06	.00	.00
PLASTERERS	.06	.57	.00	.00	.00	.00	.00	.00	.00	.00
PLUMBERS AND PIPEFITTERS	4.93	4.67	.33	.44	.36	.48	.04	.03	.00	.00
ROOFERS AND SLATERS	1.20	1.19	.01	.01	.01	.01	.01	.01	.00	.00
STRUCTURAL METALWORKERS	1.20	1.15	.34	.17	.24	.28	.00	.00	.00	.00
FOREMEN NEC	2.79	2.91	4.49	4.46	4.58	4.43	3.59	4.09	1.07	1.94
METALWRKG CRAFTS EXC MECH	1.29	1.43	9.35	9.54	8.54	8.61	1.17	1.59	.17	.23
MACHINISTS AND RELATED OCC	.07	.06	2.69	2.73	4.32	4.76	.23	.42	.06	.04
BLKSMITHS, FORGMN, HAMMERMEN	.03	.04	.07	.08	.12	.12	.01	.02	.00	.00
BOILERMAKERS	.18	.12	.07	.06	.10	.09	.00	.00	.00	.00
HEAT TREATERS, ANNEALERS	.00	.00	.11	.11	.19	.18	.00	.00	.00	.00
MILLWRIGHTS	.16	.19	.35	.35	.42	.41	.06	1.05	.11	.16
MOLDERS, METAL, EXC COREMKRS	.00	.00	.28	.20	.49	.47	.00	.00	.00	.00
PATTERNMAKERS, METAL, WOOD	.00	.00	.20	.23	.33	.36	.04	.03	.00	.03
ROLLERS AND ROLL HANDS	.00	.00	.15	.14	.26	.24	.00	.00	.00	.00
SHEET METAL WORKERS	.92	1.02	.44	.45	.73	.72	.03	.04	.00	.00
TOOLMAKERS AND DIEMAKERS	.00	.00	.97	1.11	1.58	1.76	.02	.02	.00	.00
PRINTING TRADES CRAFTSMEN	.00	.00	1.46	1.34	.12	.13	.03	.04	.00	.00
COMPOSITORS, TYPESETTERS	.00	.00	.60	.64	.04	.05	.03	.04	.00	.00
ELECTROTYPERS, STEREOTYPERS	.00	.00	.02	.02	.00	.00	.00	.00	.00	.00
ENGRAVERS EXC PHOTOENGRVER	.00	.00	.06	.07	.04	.04	.00	.00	.00	.00
PHOTOENGRVRS, LITHOGRAPHERS	.00	.00	.16	.22	.02	.02	.00	.00	.00	.00
PRESSMEN, PLATE PRINTERS	.00	.00	.41	.40	.07	.07	.00	.00	.00	.03
TRANSPORT AND PUB UTIL CRAFT	.24	.31	.08	.13	.12	.18	.02	.02	.01	.01
LINEMEN AND SERVICEMEN	.24	.31	.06	.10	.10	.15	.00	.00	.00	.00
LOCOMOTIVE ENGINEERS	.00	.00	.02	.02	.02	.02	.01	.01	.01	.01
LOCOMOTIVE FIREMEN	.00	.00	.00	.00	.00	.00	.01	.01	.00	.00

The matrix may be completed by placing in each cell either the appropriate percentage coefficient or the absolute number, obtained by multiplying the percentage by the size of total employment. The following table, derived from Tomorrow's Manpower Needs, illustrates the system, and it will be seen that summing over a column yields the total employment (100%) within that industry group, and, when absolute numbers are inserted, summing over a row gives the total employment in that occupational group.

	Ag	Con	Man	Trans	Trade	Fin	Ser	Ed & Govt
Prof/Tech	1.9	5.8	9.2	6.9	2.1	3.4	22.8	44.8
Mgrs.	.7	10.4	6.0	8.0	21.9	21.7	7.8	5.8
Sales	.3	.3	2.6	1.0	21.5	17.9	.9	.1
Cler.	.9	5.0	12.8	25.3	16.7	48.3	17.0	24.2
Craft.	.9	51.3	18.9	21.4	7.5	1.7	7.2	5.4
Ops.	2.8	8.9	43.9	25.1	12.6	.4	7.7	2.5
Labs.	4.4	17.8	5.0	9.4	4.2	1.4	2.2	2.1
Farm	87.7	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Serv.	.3	.4	1.4	2.9	13.4	5.6	34.4	15.1

MARINE EMPLOYMENT

Having produced a picture of total U.S. employment, the next step was to relate it to marine employment. This involved ferreting out the marine-related industries and occupations. It is easy to find evidence that most Americans are unconscious of, or at least unaware of, their marine environment. For more than 100 years, the U.S. Department of Labor and its predecessor agencies have reported national employment statistics. In spite of the economic importance of fishing, shipping and other marine-based employment, such information has been buried or dispersed among ten to fifteen typically land-based industry titles, severely limiting the usefulness of these figures when they are applied to marine employment.

Marine industries are located throughout the four-digit S.I.C. code system. The codes deemed to have the most significant association with marine employment are:

EMPLOYMENT SETTING	SIC CODE(S)
AQUARIA/MUSEUMS	7999, 8411, 8421
BOAT BUILDING	3732, 5551
MARINAS	4469, 5541, 7399, 7997, 7999
SPORT FISHING	5941, 7999
ADVISORY SERVICES	7399, 8999
EDUCATION AND TRAINING	8211, 9711
REGULATORY/ENVIRONMENTAL	9199, 9511, 9512, 9621
RESEARCH AND DEVELOPMENT	8922
AQUACULTURE	0279, 0921
COMMERCIAL FISHING	0912, 0913, 0919
MINING AND PETROLEUM	1061, 1311, 1381
SEAFOOD PROCESSING	2091, 2092, 5423
MARINE CONSTRUCTION	1629, 4469, 5088
WATERWAY AND OCEAN ENGINEERING	1389, 4811, 8911
SHIP BUILDING	3731, 1721, 1751, 7699
MERCHANT MARINE	4411, 4421, 4422, 4423
INLAND OPERATIONS	4431, 4441
PORT AND HARBOR	4452, 4 & 9, 4463, 4 & 9, 4782, 6331, 8611
OFFSHORE SUPPORT	4452, 4453

A close examination was made of the S.I.C. industry types. For example, SIC 373, "ship and boat building", groups together fabrication of both large and small craft, even though the occupational structure and manpower requirements found in the two industries are vastly different. In shipbuilding, the occupational skill content is based on heavy steel fabrication using metal working tools and techniques. Much of the work must meet rigorous Federal Maritime standards. Skilled workers including electricians, machinists, and similar craftsmen only work at certain stages of building the ship or vessel. This practice is similar to the construction industry. Thus, the workers follow patterns of industrial relations similar to the construction industry and face various job insecurities common to the building trades. This, in turn, results in special manpower supply problems in shipbuilding. In 1975 there is a shortage of work in one part of the country and a manpower shortage in another part of the country.

In boat building, capital requirements are far less than in shipbuilding. Work can go on all year, particularly for craftsmen, and the occupational skill requirements deal with woodworking tools, plastics and an infinite variety of specialty skills such as instrument repair, sail making, small engine maintenance, electronics, etc.

Two hundred different marine industries were identified as potential marine employers or establishments that employ a significant number of persons who require training in a marine-based skill. Time and resources available to this project made it necessary that some industries be deleted from this investigation. For example, marine insurance underwriters employ full-time Marine Surveyors who must determine, by on-site inspection, the insurable value of a water craft. There are approximately 5,000 full-time Marine Surveyors in the United States. With increasing boat sales, the number of Surveyors employed and needed in the future will continue to expand. However, the number of Marine Surveyors to total employment in the insurance industry is not sufficient to have included insurance as a marine employment setting, but the importance of the occupation makes it necessary to include it in the report.

For employment information, B.L.S. and Census data were matched to the various marine-related industries and employment settings. Because these matches were not exact, estimates were necessary. The available data were carefully evaluated for their compatibility, timeliness, sample size, and assumptions (such as economic, social, and technological trends). In many cases, corroborating data were sought from independent sources, such as trade associations and unions, in order to refine the estimate. In general, however, B.L.S. data proved to be the framework for the overall marine manpower data and a major source of reliable information, since that agency has systematically evaluated and adjusted the accuracy of its data and projections. The distribution by occupational classification within each marine employment setting was based on the corresponding percentage distribution from Tomorrow's Manpower Needs.

Marine employment by industry and by occupational family is displayed for 1975 (Table 2) and projected to 1980 (Table 3). A separate matrix has been prepared for each of these two time periods.

Following the two tables, manpower data sources are listed.

Five major sub-fields and 19 specific employment settings are described, giving special attention to the economic indicators judged important to each marine industry.

MARINE EMPLOYMENT IN THE U.S.--BY INDUSTRY AND OCCUPATIONAL FAMILY: 1975

		MARINE RECREATION				MARINE SCIENCE				MARINE RESOURCES				MARINE TECHNOLOGY			MARITIME OPERATIONS			
	TOTAL	Aquaria/ Museums	Boatbuilding	Marinas	Sportfishing	Advisory Services	Education & Training	Regulatory/ Environmental	Research & Development	Aquaculture	Commercial Fishing	Mining & Petroleum	Seafood Processing	Marine Construction	Waterway & Ocean Engineering	Ship Building	Merchant Marine	Inland Operations	Port & Harbor	Offshore Support
TOTAL	2,067,000	22,000	400,000	78,000	85,000	13,000	17,000	124,000	20,000	23,000	225,000	36,000	147,000	212,000	60,000	246,000	50,000	160,000	119,000	30,000
Scientific	27,250	480	310		20	530	7,000	4,710	870	3,460	1,530	2,280	860	260	3,800	630	10	40	150	280
Engineering	44,900	60	3,640	70	50	400	1,500	4,950	5,920	260	1,050	2,460	250	4,840	4,100	12,300	80	1,510	660	800
Technical	46,010	120	2,680	190	150	430	8,000	5,380	4,490	1,750	670	3,650	2,040	4,390	6,080	7,510	70	1,170	840	1,400
Managerial	243,220	2,160	88,530	9,120	14,250	940	600	11,690	780	2,200	19,050	5,550	17,660	25,400	9,250	9,840	1,090	18,490	11,230	450
Communications	8,950	300	430	50	130	2,960	50	910	90			650	300	30	1,050	560	60	1,110	230	40
Supportive	343,070	17,400	69,760	4,750	12,830	5,640	3,950	70,210	5,390	2,070	11,920	6,580	19,420	14,430	10,960	32,210	2,010	35,650	16,090	1,800
Sales	176,680	1,220	105,340	810	16,720	10	50	140	60	240	1,390	160	39,000	600	270	790	40	720	8,980	140
Electrical	38,940	60	8,290	1,140	520	140		1,780	30	30	50	1,110	940	10,660	1,850	10,030	60	1,130	210	970
Fitters	93,750	20	20,040	1,440	660	160		2,120	30	30	190	240	1,300	5,470	430	60,250	60	1,000	210	100
Craftsmen	284,280		38,940	17,180	8,800	540	100	6,960	230	1,560	9,050	6,440		92,510	10,740	88,520	280	5,020	2,630	190
Mechanics	157,870	180	55,610	35,340	17,340	630	260	7,790	130	180	1,050	1,990	7,000	5,010	3,320	11,130	220	3,900	6,020	780
Seamen	185,190		330	540	2,090	80	500	990	170	1,940	11,780	2,580	480	4,940	4,300	510	43,900	81,310	6,840	21,870
Longshoremen	107,590		4,740	270	4,050	120		1,530		270	1,630	690	9,640	8,970	1,150	2,140	2,060	6,080	63,570	920
Fishermen	197,420		240	3,060	8,190	420		1,280	1,810	9,010	157,380		21,040							
Laborers	116,880		16,990	4,050	4,200			3,950			5,260	1,620	27,070	34,490	2,700	9,580	90	2,980	1,040	810

TABLE 2

MARINE EMPLOYMENT IN THE U.S.--BY INDUSTRY AND OCCUPATIONAL FAMILY: 1980 (PROJECTIONS)

		MARINE RECREATION				MARINE SCIENCE				MARINE RESOURCES				MARINE TECHNOLOGY			MARITIME OPERATIONS			
	TOTAL	Aquaria/ Museums	Boatbuilding	Marinas	Sportfishing	Advisory Services	Education & Training	Regulatory/ Environmental	Research & Development	Aquaculture	Commercial Fishing	Mining & Petroleum	Seafood Processing	Marine Construction	Waterway & Ocean Engineering	Ship Building	Merchant Marine	Inland Operations	Port & Harbor	Offshore Support
TOTAL	2,359,000	25,000	432,000	95,000	90,000	15,000	18,000	144,000	23,000	25,000	250,000	40,000	150,000	259,000	78,000	290,000	55,000	195,000	125,000	50,000
Scientific	30,950	550	340		20	610	7,400	5,560	1,000	3,760	1,700	2,530	880	320	4,940	740	10	50	160	380
Engineering	52,860	70	3,930	80	50	460	1,590	5,750	6,810	280	1,170	2,730	250	5,910	5,330	14,500	90	1,840	690	1,330
Technical	54,110	140	2,890	230	160	500	3,180	6,250	5,160	1,900	740	4,060	2,080	5,360	7,900	8,850	80	1,420	880	2,330
Managerial	273, 670	2,450	90,210	11,110	15,090	1,090	640	13,560	900	2,390	21,170	6,170	18,020	31,030	12,020	11,600	1,140	22,530	11,800	750
Communications	10,460	340	460	60	140	3,420	50	1,060	100			720	310	40	1,370	660	70	1,350	240	70
Supportive	390, 940	19,770	75,340	5,790	13,580	6,510	4,190	81,520	6,210	2,250	13,240	7,310	19,820	17,630	14,250	37,970	2,210	43,450	16,900	3,000
Sales	188, 500	1,390	113,770	990	17,700	10	50	160	70	260	1,540	180	39,790	730	350	930	40	880	9,430	230
Electrical	40,560	70	3,540	1,390	550	160		2,010	30	30	60	1,230	960	13,020	2,400	11,820	70	1,380	220	1,620
Fitters	108,570	20	21,640	1,750	700	180		3,460	30	30	210	270	1,330	6,680	560	71,030	70	1,220	220	170
Craftsmen	335, 260		36,660	20,920	9,320	620	110	7,610	260	1,700	10,050	7,150		113,020	13,960	104,370	310	6,120	2,760	320
Mechanics	178, 740	200	60,060	43,040	18,360	730	260	9,050	150	200	1,170	2,210	7,140	6,120	4,320	13,120	240	4,750	6,320	1,800
Seamen	227,050		400	660	2,210	90	530	1,150	200	2,110	13,090	2,870	490	6,040	5,590	600	48,280	99,100	7,190	36,450
Longshoremen	116, 780		5,120	330	4,290	140		1,780		290	1,810	770	9,840	10,960	1,500	2,520	2,290	7,340	67,100	700
Fishermen	217, 550		260	3,720	3,380	480		1,490	2,080	9,800	174,870		21,470							
Laborers	138,000		17,380	4,930	4,450			4,590			9,180	1,800	27,620	42,140	3,510	11,290	100	3,570	1,090	1,350

TABLE 3

MANPOWER DATA SOURCES

The distribution of employment among the 15 occupational families for each of the 19 employment settings (Table 2) was based primarily on the most recent publication of Tomorrow's Manpower Needs (TMN), The National Industry-Occupational Matrix (Vol. IV, Revised 1971). The employment settings either corresponded directly with the TMN industry title (as in the case of Shipbuilding and Repair) or fell under a broader grouping of TMN industries (as in the case of Regulatory and Environmental marine occupational setting following the pattern of TMN's Government, Public Administration).

The total employment for each employment setting was based on 1975 data, either from industry publications and surveys or from the Bureau of Labor Statistics. The projections for 1980 (Table 3) relied more on TMN projections than on industry publications.

Employment Setting	Data Source
Aquaria/Museums	- Amercian Association of Zoological Parks and Aquariums - Interviews with federal agency personnel in aquarium and museum field - Interpolation of B.L.S. data
Boatbuilding	- B.L.S. (boatbuilding and repair) - National Association of Engine and Boat Manufacturers (boat and accessories manufacturing sales and service)
Marinas	- Surveys - Virginia Institute of Marine Sciences (VIMS), University of Rhode Island (URI) - Survey - National Association of Engine and Boat Manufacturers
Sport Fishing	- Bureau of Sport Fisheries and Wildlife (Dept. of Interior) - National Marine Fisheries Service (NOAA - Department of Commerce)

Employment Setting	Data Source
Advisory Services	- Surveys - VIMS, NOAA, National Academy of Sciences, B.L.S. interpolated
Education and Training	- Survey - Marine Careers Project
Regulatory and Enviromental	- Interpolation B.L.S. and Environmental Protection Agency data
Research and Development	- Study Research Projects and extrapolations from B.L.S., National Academy of Sciences, and National Science Foundation data
Aquaculture	- National Marine Fisheries Service (NOAA, Department of Commerce) - Bureau of Sport Fisheries and Wildlife (Department of Interior) - B.L.S.
Commercial Fishing	- National Marine Fisheries Service
Seafood Processing	- B.L.S. - National Marine Fisheries Service
Mining and Petroleum	- Study of number of rigs and drilling activities - Study of ocean engineering projects - B.L.S.
Marine Construction	- B.L.S. extrapolation
Shipbuilding	- Shipbuilder's Council of America - B.L.S.
Waterway & Ocean Engineering	- Corps of Engineers (U.S. Army) - Study of ocean engineering projects - B.L.S.
Merchant Marine	- Occupational Outlook Handbook - B.L.S., Special Survey and Report
Inland Operations	- American Waterways Operators, Inc. - B.L.S.
Port and Harbor	- B.L.S.
Offshore Support	- Study of Operating Rigs and Wells, Survey Sample, Louisiana

CURRENT AND FUTURE EMPLOYMENT BY SETTINGS

The following section provides an overview of each of the five major marine sub-fields and offers specific economic, political, and occupational information about each of the 19 employment settings.

MARINE RECREATION

SETTINGS	1970	1975	1980
AQUARIA/MUSEUMS	20	22	25
BOAT BUILDING	385	400	432
MARINAS	70	78	95
SPORT FISHING	81	85	90
TOTALS (Employment in thousands)	556	585	642

Recreation is the fourth largest industry in the United States, revealing the American penchant for leisure time activity. Nearly 2/3 of the population live within an hour's drive of the coast. It is currently estimated that more than 120 million people spend over $15 billion on coastal recreation; (112 million persons spent $13 billion as early as 1965). Figures supplied by the National Association of Engine and Boat Manufacturers (NAEBM) indicate that expenditures on boating alone reached $4.6 billion in 1974. The private sector (profit and non-profit) accounts for the bulk of economic activity in this sub-field. Over $3 billion was spent in 1970 for boating retail sales and saltwater anglers spent $1.2 billion. Swimmers, skin-divers, and surfers accounted for another $3.2 billion in revenues. In 1960, an estimated 44 percent of all recreationists favored water-based recreation over any other type of recreational activity. Americans indicate strong preferences for swimming, boating and fishing; between 1960 and 1970, the per capita participation in swimming, boating and saltwater fishing had risen about 50 percent. The Federal Government spent $563 million on outdoor recreation in 1972, and during the same year, state governments spent $614 million.

On the legislative side, the Coastal Zone Management Act of 1972 provides federally assisted programs of state and local planning and management to maintain and upgrade coastal zone areas for proper maximum human and land use. The Federal Boating Safety Act of 1971, which seeks to insure that boats reaching the consumer are safe, will contribute to employment opportunities. New boats and equipment must conform to Coast Guard Safety Standards, such as minimum requirements for lifesaving devices, safe loading, safe powering, flotation, and fire and explosion prevention. All of this will directly influence the demand for skilled workers who build, repair, and service marine equipment and craft.

Employment in the marine recreation industry includes occupations that are chiefly concerned with the support of man's leisure time activity on, under, or around the water. Typical places of employment include marinas for boat service and storage, recreational craft, sport fishing services, aquaria, pleasure boat building and repair, and similar commercial establishments where paid staff performs regular duties that require training and knowledge unique to the marine environment.

The demand for diversified marine recreation indicates that there is considerable growth potential and job opportunity in industries supporting such leisure time activities. The relevant marine cluster employment settings to explore are: Aquaria/Museums, Boat Building, Marinas, and Sport Fishing.

AQUARIA/MUSEUMS

Aquaria and maritime museums provide entertainment, recreation and education to millions of visitors annually. Many are also involved in research intended to support advanced training, develop conservation efforts, or provide data for local environmental impact statements. Their staff and facilities are valuable resources on which educators may draw when planning programs of Marine Education.

In 1975 there were about 550 public and private aquaria, museums, and similar facilities in the U.S., employing about 22,000 full and part-time persons. In addition, many also utilize the services of volunteers.

Technical and professional jobs usually require a strong academic background in the marine sciences. It should be noted, however, that 40 to 60 percent of the aquaria staff is made up of persons who do not work directly with marine animals - they are administration, maintenance, security and concessions personnel. Technical/professional job titles frequently include director, aquarist, plant engineer, education specialist, and curator. Aquaria and marine museums are grouped for reporting purposes with all aquariums, zoos, and museums. The estimated percentage of those which were marine was used against the total employment to determine present and future employment levels.

BOAT BUILDING

Employment in boat building and repairing occurs primarily in settings engaged in the construction and maintenance of recreational, lifesaving, commercial fishing boats and vessels, and those establishments engaged in the sale of both marine craft and equipment. Such craft include motorboats, sailboats, row boats, canoes, dinghies, houseboats, hydrofoils, life rafts, lifeboats, pontoons, skiffs, and a wide variety of others.

Bureau of Labor Statistics data project that growth in the boat building and repair industry will average 6 percent per year between 1970 and 1980. Total employment is expected to rise from 70,000 in 1970 to 110,000 by 1980. Those employed in the sales of boats and supplies greatly exceed the number reported in the manufacturing segment of this setting. The Bureau of Labor Statistics and the National Association of Engine and Boat Manufacturers report that there are 16,500 retail dealers and distributors and 2,500 manufacturers of marine products. These 19,000 firms employ approximately 330,000 full-time and 100,000 part-time persons, representing a $1 billion payroll. Retail sales in 1974 exceed $4 billion for new and used equipment, services, fuel, mooring, and launching fees, repairs, and boat club memberships.

Boat building operations are frequently carried out in close proximity to marina. However, a significant portion of the industry (twenty-six percent in 1974) is located in midwestern states. (Per capita ownership of motorboats is greater in the inland regions than it is in the coastal zones.) In recent years, the building of sail and power boats for recreational use has undergone major technological change in design, materials used, and fabricating techniques. This implies changing requirements in occupational content and training. To meet the needs of the boating industry, the NAEBM offers a series of workshops and materials development projects for schools and colleges. This school/industry cooperation provides a model for other segments of the marine field.

MARINAS

There are approximately 6,000 marinas, yacht clubs and related boating/recreation facilities in the United States providing services to sport fishermen and the boating public. This number represents private and dues paying establishments. There is an even larger number of public, city and town "marinas" providing specialized services that are maintained by public service personnel who are trained in marine-based occupations. Employment estimations of the 6,000 commercial marinas vary; however, a University of Rhode Island Sea Grant Program study reported that of the 192 New England marinas and boat yards surveyed, there are 11.6 persons employed per firm (broken down into 8.2 full-time service persons, 4.1 seasonal service persons, and 2.5 part-time service persons.) An additional survey was in progress when this report was prepared. The results should be available from the Virginia Institute of Marine Science in late 1975.

The establishments involved in the marina occupational setting, although recognized as an industry by the SIC, are not identified by an individual four-digit code for each marine employment setting. Marina operators in recent years have begun to cite the need for skilled and competent marine-oriented workers and craftsmen. Typical job titles include marina manager, dockmaster, marine carpenter, marine engine repairman and electrician. Other related jobs to be found are brokers (e.g., yacht salesmen), accountants, clerks and administrators. Many of the yacht clubs also have employees offering food and related services not usually associated with marine employment.

SPORT FISHING

According to the U.S. Bureau of Sport Fisheries and Wildlife, sixty million Americans enjoy sport fishing in the United States. More than half of this number (thirty-three million) fish more than three times a year and spend $5 billion annually on the purchase and rental of gear, boats, bait, and services. These non-commercial fishermen land an estimated two billion pounds of sport fish a year, a catch which is approaching the two and one-half billion pounds of seafood landed by the U.S. commercial fishing industry.

The Department of Interior's Bureau of Sport Fisheries and Wildlife, the Army Corps of Engineers, the U.S. Park Service, and other Federal and state agencies are actively extending those areas set aside for public recreational use through the creation of more parks and refuges on the seashore and inland waterways. The U.S. Department of Commerce, National Marine Fisheries Service of NOAA, is chiefly concerned with saltwater sport fishing while the Department of Interior's Bureau of Sport Fisheries and Wildlife promotes freshwater fishing activity.

Occupations in the sport fishing setting are primarily engaged in providing goods and services to the non-commercial fisherman and include party boat crews, wholesale brokers, retail sales persons, supply store proprietors, and guides. Chartering services, sporting goods sales, bait shops, and equipment supply firms employed 85,000 persons in 1975 and should increase employment to 90,000 by 1980.

MARINE SCIENCE

SETTINGS	1970	1975	1980
ADVISORY SERVICES	11	13	15
EDUCATION & TRAINING	16	17	18
REGULATORY/ENVIRONMENTAL	107	124	144
RESEARCH & DEVELOPMENT	18	20	23
TOTALS (Employment in thousands)	152	174	200

Most employment in Marine Science can be found at all levels of government including federal agencies, state university research projects, and local school systems. One out of five jobs in the U.S. is in the public sector. As public service employment expands, so should marine science employment.

Occupations grouped in this sub-field require fundamental training in at least one of the physical or life sciences including biology, zoology, chemistry or physics. The work performed by persons usually employed in the marine sciences includes basic research and/or development of products or services that require the use of technical data and specialized technical training. Weather forecasting and interpretation, the preparation of coastal or wetland management plans, and conducting environmental impact studies are examples of products or services provided by persons typically employed in marine science occupations. Data located thus far under-represent Marine Career related employment in each of these fields.

Marine science includes researchers, teachers and advisory, enforcement regulatory personnel, and supportive workers. About forty percent of the marine scientists work for the Federal and state governments, with another forty percent employed at academic institutions. The remaining personnel are employed within private industry. Those in industry are primarily employed by consulting or manufacturing companies within their research and development areas.

For the time being, there appear to be employment opportunities for engineers, technicians, specialists in energy-related areas, ocean-oriented social scientists such as resource economists, and lawyers. Public sector employment in 1975 reflected budgetary cutbacks at all levels of government. The impact was greatest in education and many advisory service agencies. However even conservative estimates of the growth of government predict continued expansion particularly as the Federal budget is directed toward the marine environment.

Advisory service, enforcement, and regulatory activities embody many of the newest marine science employment settings. The concern to regulate, conserve, and protect the marine environment has led to the establishment of Federal and state agencies which address themselves to local problems. At present, this is one of the fastest growing areas, but it can be expected to level off as marine resource management decisions become more routine.

ADVISORY

Advisory services can be categorized as belonging to either the public or private sector. Management consulting firms in the marine field advise private industry in the planning of new ventures, reorganization of current operations, or the installation of new technologies. A number of engineering and related private firms are employed under contract to provide specialized and technical assistance to all levels of government having responsibility in the field of marine affairs. While many Sea Grant Programs maintain advisory services, persons employed in this capacity are grouped under the Education and Training employment setting so as to be consistent with the enabling legislation that created the Sea Grant Program in line with the tradition of land grant universities.

Public sector advisory services include all of those agencies that provide technical information to the marine community as a regular public service. This includes such agencies as the U.S. Weather Service, Defense Mapping Agency, and state and county advisory and extension agents employed in marine specialities. For example, many State Agricultural Extension Services employ specialists who provide full-time advisory services to fish farmers.

In both the public and private sector, advisory service personnel fall into two major groups: scientific and engineering, and management. For the most part, all are professionals.

EDUCATION AND TRAINING

There are more than 160 colleges and universities offering degree programs in the marine field. Also, there are approximately forty 2-year colleges and technical institutes educating marine science technicians. These programs will continue as long as there is both demand for such training from prospective students and financial support from industry and government. It appears that employment levels for education personnel in the marine degree programs will respond to demand.

The most notable single Federal program with responsibility to promote the marine field in colleges and universities is Sea Grant, which was created in 1966 to do for the development of ocean resources what the Morrill Act (Land Grant Program) of 1862 did for the development of agriculture. Originally administered by the National Science Foundation, it was transferred in 1970 to NOAA. However, it has retained its original mission.

REGULATORY/ENVIRONMENTAL

While many Federal and state level agencies have the mission of assisting particular sectors of the economy to expand to meet national and regional needs, they are frequently required to function in a regulatory capacity. The U.S. Coast Guard, for example, must provide mariners with aids to navigation while at the same time license seamen who use such aids.

Enforcement of state and Federal anti-pollution measures in the marine environment will increasingly call for additional personnel who will need to bring to their job the skills of well-trained environmental managers.

In the 1960's, the Federal government supported an oceans program on a broad front leading to the Marine Resources and Engineering Development Act of 1966. Private industry was also moving into the marine environment to exploit both coastal zones and undersea resources. In 1970, the Environmental Policy Act became law representing a high level of concern by Congress and the public to protect our natural resources.

The creation in 1970 of the Council on Environmental Quality, the Environmental Protection Agency, and the National Oceanic and Atmospheric Administration marked continued advances in ocean interest. With underwater energy resources a prevailing interest today, more Federal and state agencies have assumed ocean interests and responsibilities, notably the Department of Interior and the Federal Energy Administration. Future legislation in the areas of coastal zone management, environmental protection, and energy development is likely to stimulate further growth or employment in the public sector. Both Federal and state regulatory agencies will offer increased employment opportunities for personnel trained in marine skills.

RESEARCH AND DEVELOPMENT

At the core of marine-related explorations and technological advances are the research and development activities of government, educational, and private organizations. Ocean research leads to important geological, biological, chemical, physical, and meteorological discoveries Deep sea drilling provides information about the continental crusts, their rocks, fossils, and deposits. Industrial firms along the northeastern Atlantic Coast are sponsoring a study of ocean circulation in the Gulf of Maine. These are but a few of the numerous research activities carried out every day in the marine environment. Some research is conducted on an international basis. An example is the Global Atomospheric Tropical Experiment (GATE), which mobilized 4,000 persons and thirty-eight ships to attain a better understanding of the tropical oceanic and atmospheric processes important in generating the world's weather, so that better long-range forecasts can be obtained.

The flow of Federal and private grants, the increasing demands for products from the sea, and the search for new sources of energy and minerals all indicate pressure for continued and expanded research and development activities in the marine field. Current and projected employment is difficult to estimate from available data. However, some derived estimates can be extrapolated from percentages of total research activities under the relevant SIC's. Because of uncertainties in future Federal funding, the employment figures reported here reflect conservative estimates.

MARINE RESOURCES

SETTINGS	1970	1975	1980
AQUACULTURE	20	23	25
COMMERCIAL FISHING	190	225	250
MINING & PETROLEUM	33	36	40
SEAFOOD PROCESSING	143	147	150
TOTALS (Employment in thousands)	386	431	465

Faced with the need to better protect and manage its fisheries resources, the United States may soon adopt a 200 mile fisheries (economic) zone. To date, however, there is no comprehensive policy or apparatus to manage fisheries off U.S. coasts, although a start has been made by the State-Federal Management Program, initiated in 1971 by the National Marine Fisheries Service and the concerned states. The Department of Interior's Bureau of Sport Fisheries and Wildlife operates 100 fresh water fisheries in forty-two states.

Beyond national jurisdiction, fish are subject to harvest by any nation, and other nations have taken far more seafood than have U.S. fishermen. With the exceptions of the shrimp, tuna and menhaden fleets, U.S. vessels have generally deteriorated. (The shrimp, tuna and menhaden industries have adopted cost reducing technology to increase productivity and operation.) Processors have had to rely more and more on imports to meet domestic demands.

Seafood harvesting and processing are done primarily by small enterprises spread throughout the coastal states and some inland locations. There are few geographical centers of marked concentration. The processing industry is characterized by small-unit operation, with about 42 percent of the plants having sales of less than $100,000. Only 17 percent have sales of over $1 million and only 2.7 percent (forty-three plants) have sales of over $10 million.

There are 3,650 processors and wholesalers and 2,000 importers/exporters, plus an undetermined number of frozen and canned food distributors.

In 1973, the value of the nation's fish catch was placed at $907 million. The total economic impact resulting from domestic commercial fishing was estimated at $6.6 billion in value added, $5.87 billion in earnings, and 486,000 man-years of employment. The economic participation by industry segments was distributed approximately as follows: fish catching (including purchases to operate the fleets), 30%; processing, 30%; wholesale and retail trade, 35%; and transportation, less than 5%. Also in 1973, imported seafood products were valued at $1.14 billion, and impacted the economy at about $5.11 billion in value added, $4.33 billion in earnings, and 377,000 man-years of employment. Thus, the total impact on the economy of domestic landing and imports was nearly $12 billion and over 850,000 man-years of employment.

In addition to food, world demand for secure hydrocarbon energy sources and the need to exploit all available mineral supplies has precipitated considerable offshore economic activity. Employment in these activities is primarily concentrated in mining and petroleum.

AQUACULTURE

Some increase in the supply of certain fishery products may come from aquaculture, which already provides half of the nation's catfish and crawfish, a high percentage of its oysters, nearly all its commercial trout, and 20 percent of its salmon. However, as an economic activity, aquaculture has encountered difficulty in maintaining sustained growth. A few large corporations (e.g. Purina) who entered this field did not obtain sufficient returns on capital to justify their continued investment. Full development of aquaculture requires finding solutions to some major technical and envrionmental problems. More substantial investment in aquaculture might be expected as these problems are resolved, and with it could come expanding employment opportunity. Nevertheless, the present technology, and the success of many small firms depending on labor intensive efforts, suggest that aquaculture holds promise as a future source of food and employment.

The American Fisheries Society reports that an estimated 2,000 fish hatcheries, public and private, are operated in the United States. Total employment in these fisheries is estimated at 23,000, of which over 5,000 are professional and technical workers. Fresh water hatcheries are under the jurisdiction of the Department of Interior's Bureau of Sport Fisheries and Wildlife, which operates a national system of 100 freshwater fish hatcheries and other facilities in forty-two states for breeding, raising, and distributing sport fish. In sixteen coastal states, fishery experts breed anadromous fish, and forty million of these are planted annually. The Bureau stocks the Great Lakes with close to five million freshwater fish, and plants another twenty million warm-water fish in reservoirs across the nation. Inland fishing spots are stocked with over 110 million fish each year.

The objectives of Federal efforts in aquaculture are to develop the methodology and demonstrate the biological, economic and engineering feasibility of aquaculture systems as a means of establishing fisheries under man's control. The NOAA/National Marine Fishery Service programs provide important information for the encouragement and development of commercial aquaculture systems.

Because much current activity is in the public sector, it is not now possible to derive reliable estimates of present and future employment levels in this industry.

COMMERCIAL FISHING

In 1975 the U. S. Commercial Fishing Industry has again emerged as a competitive industry. Total full-time and part-time employment has risen to well over 160,000 persons. In spite of considerable foreign competition, the number of U. S. vessels (5 tons and over) again reached 90,000, according to Coast Guard registry documents. The dollar value of fish and shellfish landings makes Commercial Fishing a billion dollar industry. At the close of the 1960's, industry observers were viewing a sharp decline in commercial fishing, but extensive use of the catch for industrial products and the all time high U. S. per capita consumption of fish and shellfish - now nearly thirteen pounds - has offered expanding markets for this national industry. Although commercial fishing statistics tend to fluctuate markedly from year to year, the overall growth pattern indicates continued expansion under normal conditions. It is not now possible to project the amount of expansion that might be precipitated by enacting a 200 mile limit. Most indicators, such as weight and value of the catch and investment in craft, imply favorable employment settings well into the 1980's.

The U.S. fishing industry suffers several difficult problems, such as poor resources management and consequent fisheries depletion, pollution and environmental deterioration in estuarine and coastal areas, and technological disadvantagement by the domestic coastal fin-fishing fleet in competition with larger and better equipped foreign fleets. In addition, damage by foreign fishermen to U.S. lobster pots and other equipment off U.S. shores, as well as seizure of U.S. boats and equipment off foreign shores, have contributed to the current difficulties.

The Federal government is assisting the U.S. fishing industry to restore its viability through several means, such as encouraging the catching of underutilized species like eel and octopus and developing methods of marketing these products.

MINING AND PETROLEUM

All offshore mining and petroleum, including mineral extraction, sand and gravel quarrying, petroleum operations, and related offshore geophysical activities are treated as Marine Resources. While the search for petroleum captures most of the publics' attention in 1975, considerable mineral resource recovery has taken place in the U.S. for more than a century. Salt obtained through solar evaporation of sea-water has been a significant source of domestic supply. Sand and gravel operations provide employment in coastal zones as well as on inland waters.

Recent and more exotic mining activities include the exploits of the Glomar Challenger designed to extend our capacity to recover minerals from the sea bottoms. At present there is no accurate data available to assess the marine reserves of recoverable minerals such as manganese nodules.

Offshore oil production now accounts for twenty percent of the world's consumption, and will supply up to one-third of the total produced by 1985. It has not been possible to construct an accurate financial picture of all facets of the offshore petroleum industry in the U.S. Much of the existing data are contradictory and even Federal agency reports on this industry are unstable. For example there has been little consistency between figures reported by the U.S. Geological Survey and the Federal Energy Administration. Even though the available data are not always consistent, the enormous potential of undersea oil reserves has attracted private industry to move offshore at an unprecedented rate. This can be demonstrated by examining a single segment of the industry that will require trained personnel, the Mobile Offshore Contract Drilling Industry:

"The demand for the services of offshore contract drillers is illustrated by the 1974 record of 138 drilling rigs (74 semi-submersibles) under construction, with the majority scheduled for delivery over the next few years. Approximately seventy-five rigs were on order last year (1973), thirty rigs two years ago, and less than ten three years ago. The estimated cost of current industry expansion is approaching $3.0 billion, representing more than a doubling in the value of equipment in operation." (Source: Ocean Drilling & Exploration Company, 1974 Annual Report.)

SEAFOOD PROCESSING

The seafood processing industry is limited to the actual processing, packing, canning, and freezing activities of 3,600 plants located across the United States. However, the overall economic and employment impact of food-from-the-sea goes considerably beyond these plants. For example, there are over 2,000 importers/exporters of frozen and canned seafood products who support distributors, chain stores, restaurants and institutional buyers. The industry is extensive and diverse.

The processing industry is characterized by small unit operations; only a few large companies exist, and they are small in comparison to companies in other areas of food processing. In dollar terms, however, the U.S. catch, (valued at $1 billion) and imports (valued at $1.5 billion) provide the raw materials for a $3 billion seafood processing industry.

Employment in the seafood processing industries will continue to rise into the 1980's, owing to rising American seafood consumption, a higher yield domestic catch, and improved technology. Seafood technologists are continuing to develop practical and economic uses for fish products, and improved marketing now permits a more complete utilization of fish species previously considered undesirable.

MARINE TECHNOLOGY

SETTINGS	1970	1975	1980
MARINE CONSTRUCTION	197	212	259
WATERWAY & OCEAN ENGINEERING	53	60	78
SHIP BUILDING & REPAIR	230	246	290
TOTALS (Employment in thousands)	480	518	627

Marine technology represents the applied or production end of research and development. It encompasses the knowledge, equipment, techniques, and facilities necessary to develop more effective uses of resources. Because most of its support comes from the private sector, there is a concentration of effort on areas of reasonable economic return.

Contributions to marine technology development have come from a variety of sources which include individual entrepreneurs, specialized companies, large industries, universities, and the federal government. The U.S. Navy has the largest federal technology program, but because of security requirements, it is difficult to fully assess its impact. For that reason, most accessible marine technology must be examined in light of the existing private industrial base.

Persons employed in this sub-field are chiefly concerned with the practical application of science and technology to the marine environment. Three distinct economic activities identified within this category are Marine Construction, Waterway and Ocean Engineering, and Shipbuilding. Employment in Marine Construction is limited to those jobs that build, maintain, repair or salvage structures on or under the water including platforms, footings, cables, pipelines, instruments, and machinery. Waterway and Ocean Engineering supports all of these activities through design, research, and development across the entire field of marine technology. Shipbuilding includes the design, fabrication, maintenance,and repair of all commercial craft used in water transportation (and a number of off-shore activities such as drilling platforms, including both mobile and stationary units.) Roles within this employment setting range from technician to engineer, deck support staff to marine laboratory assistant, and many of the job titles found onshore in the petroleum industry.

MARINE CONSTRUCTION

Marine Construction industries include the designing, building, maintaining, repairing, or salvaging of structures on or under the water, including platform, footing, cables, pipelines, instruments, and machinery.

Employment in marine construction is anticipated to increase from the mid-70's through the '80's due to the increasing need for deepwater ports to handle supertankers, which at present can be accomodated in no U.S. port. Development of deepwater ports will involve moorings and connection by hoses to submarine pipelines that lead to shorebased storage tanks, mooring platforms, and artificial islands upon which storage tanks and employee housing might be built. In addition to encouraging deepwater ports, the Federal government anticipates investing $309 million by 1980 in a program to design, construct and improve other harbors and waterways to meet the needs of shipping, fishing and recreational boating.

The Standard Industrial Classification does not isolate Marine Construction activities. At present these activities--such as submarine rock removal, wharf construction, dock construction, and waterway construction--are included with thirty other types of construction, both off and on-shore in the "not elsewhere classified" category. Some employment level figures are available, such as for ship officers within Marine Construction. However, the Bureau of Labor Statistics has not yet determined employment levels for all occupations within the Marine Construction category.

SHIPBUILDING AND REPAIR

The Merchant Marine Act of 1970 was enacted to increase U.S. shipbuilding productivity, up-grade the industry's competitiveness in the world market,and decrease dependency on government construction aid. The Act provided for 300 new ships to be built between 1970 and 1985.

As a result of the Act, employment in the shipbuilding and repair industries is projected to rise from 210,000 in 1970 to 319,000 by 1980, which will further complicate an already difficult manpower situation.

Owing to several factors, the ship building and reapir industry is continually faced with high turnover among its employees. Due to shortages in critical skill areas (such as shipfitters, marine machinists, and pipefitters), new hires are often classified above their actual qualification level only to be fired or quit later as a result of their incompetent skills. There are recurring gaps in the construction schedule which produce lay-offs and many employees secure other employment before recall. There are also problems with the wage structure in that there is not enough pay differential between skilled craftsmen with tenure and the new employees. In addition, wage increases have not kept pace with the construction industry and other manufacturing industries. Thus, on an annual basis, eighty percent of the new hires are to replace workers who have been discharged or have quit and twenty percent of the hires are to provide for increased production requirement.

WATERWAY AND OCEAN ENGINEERING

This employment setting is made up of two segments, 1) all of those engineering firms that service marine construction, shipbuilding, and repair but have not been counted in these settings; 2) The U.S. Army Corps of Engineer's Civilian Workforce and private contractors who work on Corps projects. Again double counting with Marine Construction has been avoided.

Engineering employment chiefly concerned with offshore activity is 15,000 while 45,000 workers provide engineering services for all Corps projects.

Research and Development activity over the past decade has resulted in the identification and planning of many offshore projects that require engineering services for their design and implementation. The Louisiana Offshore Oil Port (LOOP) is a single example. The design and bringing on station of new electronics fixed navigation systems utilize considerable engineering manpower. New energy producing mechanisms will soon move from the R & D phase and will require skilled ocean engineers and support personnel to be installed and made operable.

The Corps of Engineers is responsible for the development, operation, and maintenance of harbors, canals, and river improvements. Although it works mainly through private contractors, it also operates a fleet of 3,000 vessels (dedges, barges, pontoons, and other floating equipment) needed to carry out its work. The Corps maintains 400 harbors, operates 700 flood control projects, and currently spends over $1 billion annually on new water resources development projects. The U.S. invests over $115 million per year to maintain its 25,000 miles of inland and coastal waterway.

MARITIME OPERATIONS

SETTINGS	1970	1975	1980
MERCHANT MARINE	45	50	55
INLAND OPERATIONS	153	160	195
PORT AND HARBOR	114	119	125
OFFSHORE SUPPORT	26	30	50
TOTALS (Employment in thousands)	338	359	425

The single distinguishing characteristic separating offshore maritime work and selected inland operations from all other marine employment is the requirement to meet Coast Guard certification. Such certification is dependent on meeting health and job performance standards on tests regularly administered by the United States Coast Guard.

This sub field has been greatly influenced by recent legislative actions. A 1975 Bill voted by Congress and vetoed by the President would have required that twenty percent of American's crude oil imports be carried on United States flag ships, rising to twenty-five percent by July 1, 1977. The advocates of this legislation argue that it would create jobs for American seamen and add to the national defense. Other maritime interests claim that such legislation will result in the consumer paying higher prices for gasoline, heating oil,and industrial products because of higher fuel costs.

Maritime Operations should experience increases in its manpower requirements due to the Merchant Marine Act of 1970, which could substantially revitalize the American shipping industry. The availability of construction subsidy funds has provided a base by which the shipping industry can develop new fleets to replace the old World War II built tonnage. One effect of the Act has been increased activity in the Great Lakes ports and harbors as a result of new dry bulk carriers and smaller vessel construction and operation.

Approximately 1,850 companies are engaged in commercial operations on over 25,000 miles of U.S. navigable inland waters, utilizing 18,000 dry cargo barges and scows, and 4,300 towboats and tugs. The total investment of all for-hire carriers operating on the inland waters in carrier equipment only is estimated at more than 2 billion dollars. This is exclusive of terminals and other shore-based equipment.

Special skills and training are required of the personnel who staff and operate craft supplying offshore construction and extractive industries. The merchant marine is limited to large tonnage deep sea and Great Lakes shipping, while inland operations include tugboat operations, barge traffic, and cargo and passenger operations. Harbor and port facilities provide employment for persons who are chiefly concerned with the loading, unloading, and supply of commercial shipping.

MERCHANT MARINE

Maritime transportation of all types contributes to the Nation's economy and security. Although most of the United States' foreign trade cargo moves by sea, vessels of U.S. registry carry only about five percent by weight of the total. Between 1950 and 1970 many American corporations transferred their ships' registration from the American flag fleet to foreign flags, usually Liberia and Panama. These flags of "convenience" (union term) or "necessity" (management term) provide the corporations with foreign maritime labor, avoidance of U.S. taxes, lower construction and operation costs and greater operational freedom. The result has been a decreased employment opportunity for American seamen. The U.S. seamen is also victim of technology displacement. Fewer men are needed to operate the larger modern vessels, especially the very large cargo carriers, (VLCC's) of one and two hundred thousand ton deadweight.

The merchant marine in 1975 may be on its way out of a slump that had its start shortly after 1945 or the end of World War II. Persons employed in the industry who were only in their 30's at the end of World

War II and who continued to sail over the following years are now approaching retirement age. While over-all employment levels have remained fairly even over the past decade, a serious shortage has been felt in the ranks of middle grade ships officers particularly among Second and First mates and Engineers and certain key unlicensed ratings. Ten maritime academies and industry sponsored upgrading programs can provide some limited supply for the entry level engineering and mates positions. However, attrition rates among young officers remains high.

There are three occupational branches in this career field: deck, engine, and steward (see page 2-3). From an entry level position in any of the three departments it is possible to work one's way up to the top position, but lateral transfers between departments are seldom possible. Ordinary seaman can train at sea and eventually climb to a berth as a Third mate, and even eventually become a ship's master. Similar job mobility is possible in the engine and stewards departments.

INLAND OPERATIONS

Thirty-eight of the fifty states, with almost ninety-five percent of the U.S. population, have commercial transportation services provided by vessels operating on rivers, canals, bays, sounds and lakes. One hundred and thirty of the 150 cities having a population of over 100,000 are located on commercial navigation channels. Barge service, for instance, is the lowest cost mode of transportation for bulk and packaged cargo. In recent years the increasing demand for water transportation service has stimulated improvement of water channels as well as improvements in equipment and technology of operations.

Approximately 80,000 persons are employed aboard the inland fleet. An estimated equal number of persons are employed in shore-based work directly connected with inland fleet operations. Approximately 1,850 companies are engaged in commercial operations on the U.S. inland waters utilizing 18,000 dry cargo barges and scows, and 4,300 towboats and tugs. This is an investment in excess of $2 billion; and the cost to operate and maintain the twenty-seven principal inland waterways for commercial transportation is more than $115 million a year (over $8 billion has been invested by government to develop these systems). Sixteen percent of the nation's domestic commerce is handled by barges, representing a multi-billion dollar revenue for the industry. Growth in the industry is strong and steady and the ton-miles of internal waterborne domestic commerce continues to rise faster than the gross national product.

As transportation costs increase the inland operations industries will continue to be in greater demand. Presently, barge service is one-sixth the price of rail service, the next least expensive form of domestic transport.

PORT AND HABOR

Port and harbor facilities provide employment for persons engaged in the loading, unloading, and supply of commercial shipping, inspection of cargo, and underwriting marine insurance.

Over 1.6 billion tons of cargo in our foreign and domestic waterborne trades move annually through U.S. ports. The many and varied port activities required to service this vast trade volume generate over $30 billion in direct dollar income to local and regional economies each year.

Since the end of World War II, local public port agencies have invested a total of $3 billion in new marine terminals. A major part of this total has been spent on packaged freight terminals, including innovative facilities to handle intermodal marine containers. As a result, U.S. ports are the world leaders in containership terminal capability.

The category of operatives which would include persons who operate the machines that move cargo to and from ships to docks is expected to moderate due to increased technology. Management, technical and supportive job families should increase. Containerization and LAS (lighter aboard ship) are improved cargo handling features of new merchant vessels. Moving gantry systems load and unload containerized cargo over the stern of the ship without requiring pierside space, resulting in faster transport and reduced costs and handling.

OFFSHORE SUPPORT

Offshore support includes marine towing, operation of lighters and other harbor vessels for transferring goods and passengers between ship and shore, and those establishments supporting the drilling for petroleum and natural gas in open water, rig operation,and maintenance.

Current employment levels do not accurately portray the growth expected in offshore support activities. Although the data are adequate for describing those establishments concerned with towing and transfer of goods, they do not reflect increased employment opportunities in offshore petroleum and natural gas extraction. Conversations with industry officials in the Gulf region indicate this part of the industry is undergoing serious shortages of qualified personnel. A special unit of the Coast Guard was established to accelerate certification of seamen for this industry but excessive attrition rates continued in 1975.

The Bureau of Labor Statistics is currently in the process of exploring demand, output and manpower implications of expansion of America's energy supplies from outer continental shelf drilling.

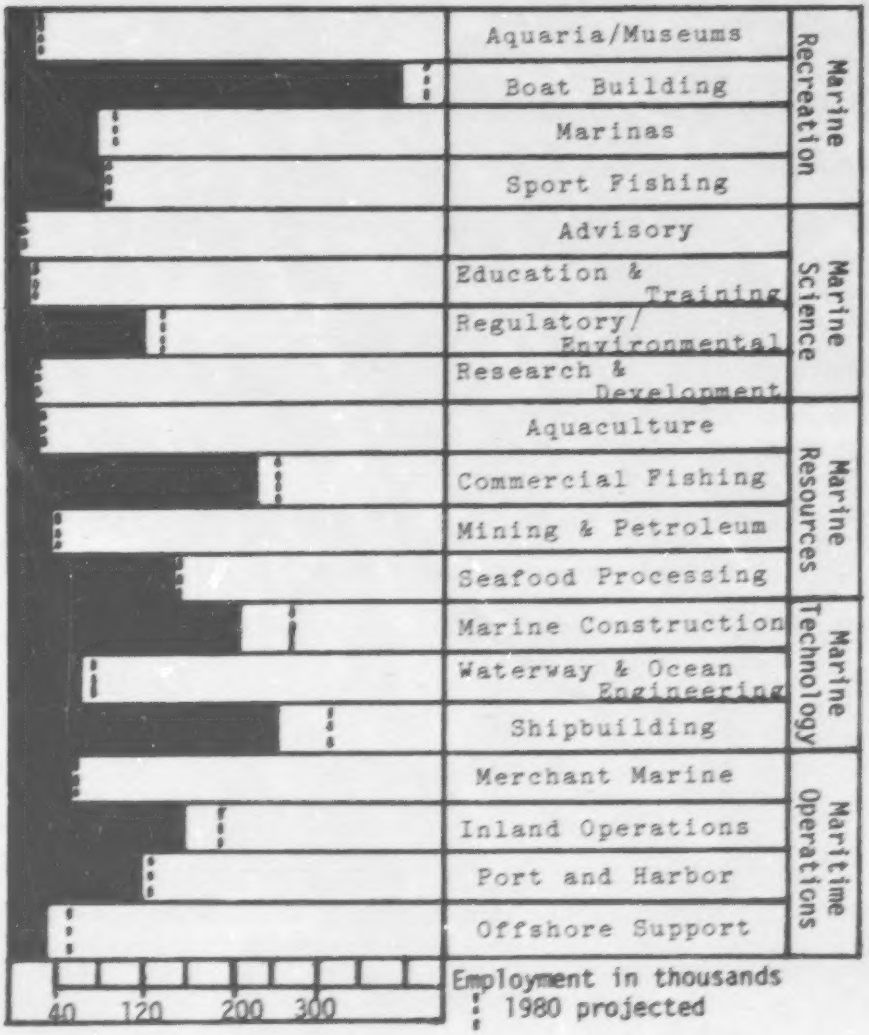
The U.S. Geological Survey, the Bureau of Land Management, and NOAA's National Ocean Survey have assessed and identified those areas of petroleum resource potential, in addition to having inspected industry plans and activities to assure maintenance of safe and efficient operations following the lease sales. Once environmental impact studies and negotiations between the Federal and state governments have been finalized, rapid expansion in employment opportunities, especially off the Atlantic seaboard, should occur.

A few states on the Atlantic Coast have already begun to anticipate the consequence of offshore operations in their region and have begun planning programs to assist local communities to make the adjustment that will be required when drilling begins on the outer continental shelf.

MANPOWER CONCLUSION

By combining the employment characteristics and outlooks of all 19 employment settings, some overall conclusions can be drawn about marine manpower prospects for the U.S. A reasonable rate of growth is forseen across all the sub-fields, with expansion projected for every employment setting. The greatest expansion in absolute numbers will occur in the largest employment settings, as demonstrated in the following graph:

Marine Employment in the U.S. by Setting: 1975



Substantial job openings will occur in marine construction, shipbuilding, and boatbuilding. Two of these are in the Marine Technology sub-field. On the other hand, three of the four settings in the Marine Science sub-field are among those for which the least expansion is projected. Data available to the Marine Careers Project do not indicate that any of the settings are likely to suffer a contraction of employment.

A caveat is in order regarding the interpretation and application of this aggregated, national perspective. There is enormous regional diversity in employment which is not within the scope of this report to detail. For example, although marinas and sportfishing are not among the leading employers nationally, in some areas (such as parts of the Midwest) they are the major marine industry. For example, Minneapolis-St. Paul is the country's leading metropolitan market for outboard motors. Such variation in the relative importance of employment settings suggests that regional as well as national characteristics should be taken into account when deciding on the merits of different Marine Career emphases. National Employment levels reported in this study provide a framework for developing regional data. The use of industry advisory committees drawn from local labor markets can be of considerable assistance in this effort.

Marine industries and marine occupations, while not easily identifiable in conventional labor market reporting publications, provide substantial employment in all parts of the country. Total employment in 1975 approaches that of Agriculture and is in expansion. In short, the Career field is viable and growing stronger.

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EXTENT OF
MARINE EDUCATION
PROGRAMS

Having established that there is a significant demand for persons possessing marine-related skills, it is logical next to inquire into the kinds and number of programs currently responding to that demand. The Marine Careers project had as its second objective precisely such a study, being mandated to focus particular attention on the extent of educational programs and curricula presently available in grade levels K-14.

As will be described below in more detail, the principal finding was that current program offerings are as a whole noteworthy for their scarcity, narrowness, fragmentation, isolation, academic bias, and neglect of market realities. Most programs are ad hoc, treat only a few careers among the many that are available in the marine area, and reach only a few students in the highest grade levels. However, the study also found a quickly developing trend toward expansion, both in the number of programs mounted and in the comprehensiveness of those programs.

The study emphasized vocational development within the four-step conceptual framework of Career Education. Consequently, specific criteria were developed and applied in order to identify and include the major programs relating to each of the Career Education phases. These criteria included the advice of Sea Grant Marine Advisory Service educational specialists; the suggestions of U.S. Office of Education and State Department of Education vocational education specialists; a substantial level of funding; frequent citation in the literature and similar indications that a program has received national recognition; and unique characteristics such as serving handicapped, disadvantaged or other special client populations.

The complexity and variety of program offerings in marine education posed a special problem in identification and classification. In order to reduce the large number of known program offerings to a manageable format, a matrix was developed to facilitate the selection of representative examples of programs by level, type and location.

The project staff was able to collect information describing over two hundred programs. From this data, 50 programs were initially selected for on-site investigation. Ultimately, visits were made to 64 programs representing each educational level and region of the country. The table on the following page displays programs visited by level, type and region.

The increased public interest and concern for the environment that began in the sixties influenced curriculum developers to design programs that emphasized leaving the classroom for the "living laboratories" of the out-of-doors.

Selected Marine Education Programs in the U.S.

LEVEL	PROGRAM	TYPE	REGION
Elementary	Oyster River School, NH	Marine Biology	New England
	Mass Marine Educators Assn., MA	Marine Biology, Oceanography	New England
	Plymouth Regional, MA	Marine Biology	New England
	NE Aquarium, MA	Marine Biology, Ecology	New England
	Project Oceanology, CT	Oceanography	New England
	Chesapeake Bay Lab., MD	Fisheries	Atlantic
	Marine Science Station, FL	Aquatic Research	Gulf
	John G. Shedd Aquarium, IL	Marine Biology	Midwest
	Orange County Floating Lab., CA	Marine Biology, Oceanography	Far West
Middle School	Mystic Marinelife Aquarium, CT	Marine Biology	New England
	Sea Ventures, NJ	Oceanography, Sport Fishing	Atlantic
	District of Columbia Schools, DC	Marine Biology	Atlantic
	Living Materials Resource Center, TX	Marine Biology	Gulf
	Corpus Christi Independent S.D., TX	Marine Biology	Gulf
	Steinhart Aquarium, CA	Research, Recreation	Far West
Secondary	Canton High, MA	Marine Biology	New England
	Tabor Academy, MA	Marine Biology	New England
	Cranston High, RI	Marine Biology	New England
	N. Kingston H.S., RI	Fisheries	New England
	Oceanic Education Foundation, DC	Marine Biology	Atlantic
	N. Carolina Districts 1 & 2, NC	Envir. Sci., Mar. Biol.	Atlantic
	New York Maritime H.S., NY	Nautical Science	Atlantic
	Houston Independent School District, TX	Marine Biology	Gulf
	Terrebonne Parish School Board, LA	Nautical Science	Gulf
	Marine Ecological Institution, CA	Ecology	Far West
	Alameda-Contra Costa County, CA	Environmental Studies	Far West
	Harbor High School, CA	Instrumentation	Far West
Post Secondary	Southern Maine Voc. Tech. Instit., ME	Marine Science Technology	New England
	Univ. of Rhode Island, RI	Fisheries	New England
	Cape Fear Voc. Tech. Instit., NC	Marine Science Technology	Atlantic
	Suffolk County, C.C., NY	Aquaculture	Atlantic
	Miami-Dade J.C., FL	Marine Electronics	Gulf
	Florida Keys, J.C., FL	Aquaculture	Gulf
	Del-Mar College, TX	Electronics	Gulf
	Brazosport College, TX	Marine Technology	Gulf
	Florida Institute of Technology, FL	Ocean Engineering	Gulf
	College of Marin, CA	Individualized Instruction	Far West
	College of The Redwoods, CA	Fisheries	Far West
	Orange Coast College, CA	Marinas	Far West
	Santa Barbara City College, CA	Diving	Far West
	Highline Community College, WA	Diving	Far West
	Shoreline Community College, WA	Lab. Technology	Far West
	Clatsop Community College, OR	Fisheries	Far West
BS and Advanced Studies	Mass Maritime Academy, MA	Merchant Marine	New England
	Woods Hole Oceanographic Inst., MA	Research	New England
	Virginia Institute of Marine Science, VA	Marine Science	Atlantic
	US Merchant Marine Academy, NY	Merchant Marine	Atlantic
	Univ. of Miami, FL	Marine & Atmospheric Science	Gulf
	Univ. of Wisconsin, WI	Oceanography, Limnology	Midwest
	Univ. of Southern Cal., CA	Marine Science	Far West
	Bodega Marine Lab, CA	Research/ Application	Far West
	Institute of Marine Studies, WA	Interdiciplinary	Far West
	Univ. of Washington, WA	Marine Science	Far West
CETA/ Skill	Quincy Shipyards, MA	Shipbuilding	New England
	Gen. Dynamics Electric Boat Div., CT	Boatbuilding	New England
	Newport News Shipbuilding Co., VA	Apprenticeship-Fitter/Welder	Atlantic
	Deep Sea Ventures Inc., VA	Ocean Mining	Atlantic
	Pace Fish Co., TX	Fish Processing	Gulf
	Harbor Occupational Center, CA	Marine Skill Training	Far West
Continuing/ Other	U Mass Aquaculture Project, MA	Aquaculture	New England
	Maine Dept. of Natural Resources, ME	Extension	New England
	Comm. of Virginia Maritime Museum	Public Ed./Extension	Atlantic
	Univ. of Texas, Extension Div., TX	Marine Recreation	Gulf
	Marineworld, IL	Public Education	Midwest
	UBC Marine Advisory Service, CA	Advisory	Far West

The awareness students gained from such programs about the interrelationships and dependencies of the earth's organisms seems to have set in motion an increased desire to learn about things marine. The popularization of marine activities, recreational as well as educational, has served to advance this interest. Unfortunately, however, the American educational system is not institutionally equipped to respond with systematic, comprehensive new programs in such relatively short time.

This lack of infrastructure for designing and implementing new marine programs has resulted in fragmented, inadequate, and duplicative programs, developed here and there by motivated and dedicated individual instructors. Typically, such teachers have perceived the need for these programs and have launched out virtually unassisted to find the necessary information from which to design instructional units. During the course of such a first effort, the more fortunate teacher might attend workshops or institutes to become more informed, and eventually a full course may emerge, usually offered as an elective on the secondary level or for the elementary or middle levels, somehow "squeezed" into the prescribed curricula. Being the creation of a single individual, the resulting product seldom includes the collective wisdom of industry and community advisory groups whose inputs are necessary to comprehensive program design.

AWARENESS, ORIENTATION, AND EXPLORATION PROGRAMS

If we look at current marine vocational programs from the point of view of the four phases of Career Education, it is immediately apparent that the piecemeal approach to their development has resulted in virtual exclusion of all but "preparation" phase programs. Such limited programs as do exist are strongly skewed toward marine science at the expense of other marine careers which may have greater employment potential, but which are likely to be overlooked if for no other reason than that they do not fit easily as supplemental units into present biological science or other academic curricula.

The Marine Careers project has confirmed as fact that most marine education programs in elementary, middle and secondary school grades are outgrowths of existing science courses, often biology or "life science," and usually involve field trips to the beach, marshlands, aquarium, or a similar aquatic environment.

Perhaps the greatest value of such courses at the K-12 level comes when they are aimed at the student who is neither college bound nor in a vocational training program. In this instance, the natural interest of young people in the marine area is utilized as a vehicle to motivate the student in the development of those math, language, social, and problem-solving skills necessary to be a constructive member of society.

Though there are few elementary level programs which stress marine career awareness or orientation, there are some examples that demonstrate the potential scope, variety and usefulness of such programs. Some districts and schools hold annual "marine career days." Sea Grant Advisory services and some public and private organizations have begun to add career components to existing programs that are offered to local elementary schools. At the secondary level, marine science is increasingly being offered as an alternative to biology or as a supplement to an ecology program.

The most noticeable common denominators among the elementary, middle, and general secondary programs visited were high student interest levels, dedicated and motivated teachers and administrators, and the expressed desire by both students and teachers for more access to relevant information. It is also clear that existing programs cannot be unequivocally attributed to objectives corresponding to any of the three initial phases of Career Education; educators clearly have not been thinking in terms of a continuous and sustained career development process in relation to marine careers.

PREPARATION PROGRAMS

Secondary

Marine skill development programs have followed nearly the same evolutionary path as marine education courses in elementary and general secondary schools; namely, an individual instructor has forged ahead alone. The only major difference is that career preparation programs have been instituted at a much slower pace. Insufficient industry participation in program design has tended to result in inadequate skill content, poor placement records, and even collapse of the program. Programs developed in cooperation with local industry and its needs have had much greater success in placing graduates.

Secondary vocational-technical marine programs are generally confined to commercial fishing, engine and boat maintenance,and boat handling. However, examples of programs designed to meet a very specific local need can be found and used as models for future program development. Training for offshore oil support personnel in Louisiana and fiberglass boat fabrication in California are two examples.

Program directors and instructors at the secondary level repeatedly mentioned as a problem the fact that most students enrolling in marine programs have little or no awareness of the unique demands marine-related careers may make on an individual. An ironic, but not unusual example is that many students discover they are unable to overcome motion sickness. More and better introductory programs are seen as fundamental to solving the problem of a lack of prevocational marine experiences.

The lack of adequate manpower data, occupational skill requirements, and similar technical information on which to develop and design programs was often cited as the reason for not offering more marine education at this level; yet, proposals to state departments of education seeking funding for marine vocational programs are increasing at a tremendous rate in all regions of the country.

Post Secondary

A number of two year post secondary occupational education programs were started in the late 60's to answer a predicted need for marine technicians to assist the scientists and engineers involved in ocean research. Many of these programs received their early support from the Sea Grant Program. While the projected need did not materialize quite as expected, the training incorporated in most of these programs provides basic skills for employment in a wide range of marine vocations. In addition, many of the programs have been tailored to meet real needs of specific industries (e.g., diver training programs in Washington and California to provide well trained commercial divers for the offshore petroleum industry; a support vessel operator training program in Texas; training of engine and deck officers in Washington and Florida; training in marine propulsion technology for the recreation industry in Florida and for the commercial fishing industry in California). Technical institutes, area vocational schools, community colleges, and similiar post-secondary institutions have been at the forefront of marine education for the past ten years.

Continuing Education

Government, unions and industry have maintained extensive continuing education programs to meet their changing manpower needs and the requirements of evolving technology. However, many of the marine industries are either too small or too fragmented to be able to establish continuing educational programs of their own. These needs are sometimes recognized, but the evidence suggests that most of higher education is unaware of the need for closer cooperation between marine industry and academe. In the past six years, extension service activity has been given stimulus and support by the government agencies such as the National Marine Fisheries Service. The NOAA supported "Marine Advisory Service" provides consulting services to the marine industry in the manner of Agricultural Extension Services of the U.S. Department of Agriculture. In addition to individual assistance, seminars, and workshops, short courses are frequently conducted to meet the needs of local marine industries.

In some states, the technical and area vocational-technical schools and divisions of four year colleges and universities offer special evening or seasonal courses to meet the needs of local marine interests. These courses may range from marine insurance underwriting or accounting for marina operators, to welding, net mending, marketing, tax law for commercial fishermen, and marine environmental education for elementary and secondary teachers. The extension agents usually offer programs wherever and whenever a need exists. Usually the instructor is an individual who has displayed particular competence in the subject and an ability to communicate, regardless of academic credentials. There are examples of some such programs in response to local needs in almost every state which contains or borders on a major body of water.

Other Program Offerings

Aside from the uniformed services (including the uniformed Corps of NOAA) and the merchant marine, the government has played an important role in cooperation with industry in training manpower to meet specific needs. At the present time, several government agencies have authority to conduct or fund marine educational programs. For instance, the Maritime Administration provides manpower training in cooperation with the shipbuilding industry.

The military establishment is a primary source of vocationally trained manpower over a broad range of marine related occupations. Most obvious, of course, are the enlisted training programs of the Navy and the Coast Guard. Equally significant but less obvious are the training programs of the Army, which is responsible for port, harbor, and inland waterway operations for the military through its

Transportation Corps and the Corps of Engineers. The military training programs of all the services are characterized by operationally defined performance objectives, task analysis, modern training techniques, and frequently by formal agreements with the related civilian industry regarding the equivalency of the military training to its civilian occupational needs.

There remains the traditional "school of hard knocks", or the "hawspipe" as it is frequently referred to in the sea vernacular. A survey of deck officers on American-owned vessels shows that approximately 80% of the mates started out at the bottom as "ordinary" seaman and worked their way up through the ranks to chief mate and for some, ship's master. These are the men who have made "going to sea" a career, while the officer graduate of one of the merchant marine academies, if he goes to sea at all after graduation, frequently within a few years seeks a job on shore. This is not meant to detract from the value of the education received, because many of the land based jobs require a knowledge of the operations at sea that is vital to the support of that operation. A super cargo who plans and directs the loading of cargo on a freighter for a longshore company, must first be a competent seaman with the requisite knowledge and liscenses.

This report will not try to go into full detail concerning academic education in science and engineering through programs granting four-year and graduate degrees. This information is readily available through the publication University Curricula in the Marine Sciences and Related Fields, which is revised and published under the aegis of the Inter-Agency Committee on Marine Science and Engineering, the Federal Council for Science and Technology, and the Office of Sea Grant in the Department of Commerce. Every college and university marine program is described in this publication. Such academic programs are characteristically up-to-date technologically, and typically they produce a substantial supply of qualified professional personnel. Individuals trained to this level generally have sufficient employment flexibility that some elasticity in job supply and demand can be achieved.

In addition to such academically oriented programs, there are included in this publication both two and four-year programs which are occupationally oriented. Of these, the four-year programs of the U.S. Naval Academy, the U.S. Coast Guard Academy, the U.S. Maritime Academy, and the various state maritime academies constitute a major source of trained manpower as deck and engineering officers both for the uniformed services and the civilian merchant marine.

In summary, it is clear that there is a rapidly developing interest by students and educators in marine fields.

This trend is very noticeable. While only a few programs were started in the late 1960's and early 1970's, in the last year alone the West Coast states, Indiana, Rhode Island, and Hawaii all began major programs. The one in Hawaii is the first truly comprehensive statewide marine education program in the United States. The states of Delaware, Maryland, and Virginia are now in the process of establishing new programs.

Given this increasing momentum, it is likely that expansion will continue in one form or another. However, the results of this study strongly suggest that the quality, efficiency, outreach, and career impact of these new programs are likely to remain marginal in the face of vast opportunity unless much needed leadership is exerted to organize, guide, and assist their development. The most urgent need is for better and more detailed data about the content and requirements of marine occupations, without which high quality comprehensive programs cannot be designed. An occupational task analysis will provide this information.

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EXTENT OF MARINE EDUCATION CURRICULUM MATERIALS

The third objective of the study was to identify and describe existing educational materials relating to marine careers. This was done, and it was found that there is a very serious shortage of appropriate instructional materials.

In order to be comprehensive in the identification of existing and available curriculum materials, the project team explored every known computerized national data storage and retrieval system. These systems are available to the general public at various read-out terminals across the country at a nominal cost.

However, it was learned that previous attempts by educators to gather information from these sources had netted very few citations.

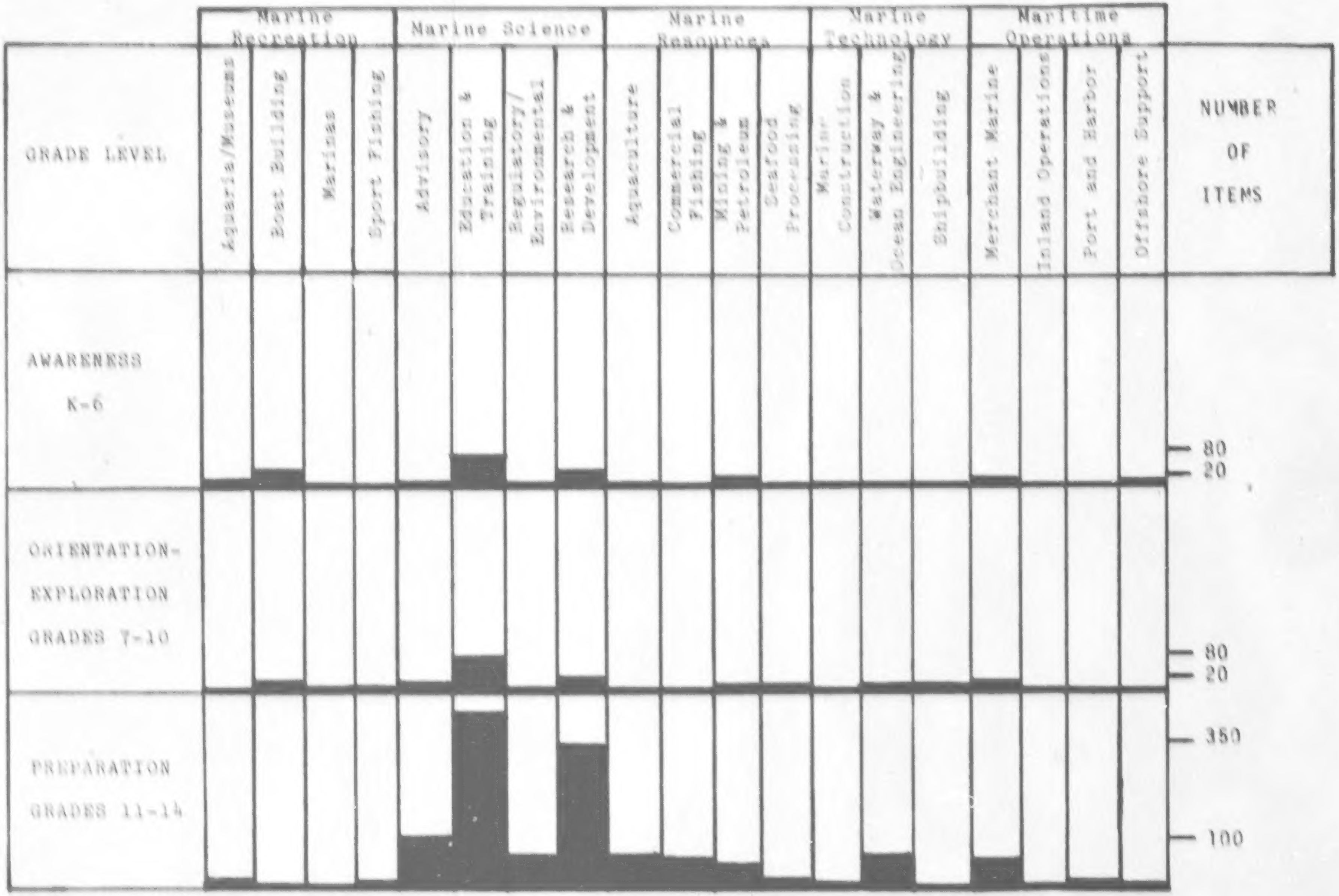
Aware of this problem, the project staff sought the advice of computer specialists at Massachusetts Institute of Technology before a search was initiated. It was found that in order to gain full access to any system it was necessary to learn the technical programming language to completely interact with the computer. Of the systems employed, the ERIC (Educational Resources Information Center) and the OASIS (Oceanic and Scientific Information System) systems were found to be the most available and comprehensive. ERIC is the educational data base developed and maintained by the U.S.

Office of Education.[1] OASIS is operated by the Technical Information Division, Environmental Science Information Center, Environmental Data Service, National Oceanic and Atmospheric Administration (NOAA).[2] It is an information retrieval service that furnishes ready reference to the technical literature and research effort concerning the environmental sciences and marine and coastal resources.

The ERIC and OASIS searches, combined with the selected bibliographies indexed by the project staff, provide in excess of 400,000 items. After eliminating the less useful items, the ERIC yield reduced to 353 citations. The OASIS data was reduced twice to the most relevant 100 items. Combined with citations from selected bibliographies and special materials collected by the project staff, a card catalogue of over 3,000 items, ranging from topics of general marine interest to those with highly specific occupational content, was assembled. These cards were then sorted according to educational level and employment setting. This breakdown is displayed in matrix form on the following page.

Lists of periodicals and journals of interest are included in several of the selected bibliographies. Examples of publications that have been of particular use to the project include The National Fisherman and Marine Technology Society Journal and trade publications like Offshore,

Distribution of Materials Assessed



Boating Industry, Ocean Industry, and Sea Technology. National Sea Grant newsletters, brochures, reports and reprints can also be a useful resource and are indexed in Sea Grant Publications Index and Sea Grant Newsletter Index.

To clarify classification and analysis of materials, a further delineation was made. Materials were defined as instructional or non-instructional (i.e., general topics). The bulk of the instructional materials gathered by the project staff were teacher-made manuals and guides developed for a particular need or unit and therefore isolated, not validated by wide classroom use, and for the most part inaccessible or unavailable.

Non-instructional or related materials are generally available but are not designed for classroom use and as such are not suitable without modification.

Identifying specific career and occupational content among the materials assessed has been a difficult and subjective task. At present, there is no material that systematically treats any marine occupation or industry in the broad Career Education framework.

The largest portion of materials generated deal with marine life and animals, beach phenomena (tides, seashells, etc.), and environmental issues. Other topics that generated a significant number of citations are diving, ecology, aquaculture, and ocean engineering.

AWARENESS, ORIENTATION, AND EXPLORATION MATERIALS

Awareness materials identified range from curriculum especially designed for school use (e.g., Marine Science for Fifth Grade) to popular books like the True Book of Oceans. Approximately two hundred and fifty (250) items were classified as awareness level materials. Of these, two thirds are supplemental science material.

Diving and undersea technology, a glamorous and adventurous frontier, has great appeal to young people and therefore numerous materials are available. Titles include All About Undersea Exploration and What Does a Diver Do?

It must be noted that very few of the materials in use at the early elementary grade levels were designed within the Career Education framework. They are classified and reported here because they represent what are currently available; however, for the most part, they do not provide a sufficient or realistic base of awareness for eventual career exploration or decision-making processes.

The same situation exists at the middle or junior high school level where career orientation and exploration usually occurs. Out of more than 300 items identified and classified for use in grades 7-10, about 70% are specific to science (marine biology, oceanography, ecology, etc.). The balance of the materials in this category tend to be very narrow in scope; for example, there are several materials which deal with undersea communication. The breadth and richness of marine-related careers are not reflected in the available materials in use.

Materials in use at the general secondary grade levels are again primarily marine biology topics, and most have no career content whatsoever. General interest type books and films are available for use in these grades depending on the reading levels of particular classes. (The Rudolph Flesch Readability Formula was applied to materials assessed and many of the so-called "general interest" books and articles written on the marine environment have a difficulty score of 4 to 5 (fairly difficult) and require reading proficiency at the 11th or 12th grade level).

A considerable volume (over 100,000 pages) of unpublished curriculum material collected by the project staff indicates that in the absence of adequate published materials many instructors are producing their own. These course outlines, bibliographies, laboratory exercises, and field trip guides represent the most common type of materials in use at the present time.

PREPARATION MATERIALS

Secondary

The materials that can be classified as specific to vocational education or skill preparation are usually isolated, often out of date and generally limited in their availability. Programs are often the product of individual initiative and materials must be created or developed from the small pool of available resources. Of the more than 3000 items cited, only about 200 are of use to vocational educators in marine industries other than the Marine Sciences, and few of these could be classified as instructional. There are many materials that can be used, or modified for use, for vocational education purposes in some of the marine settings; yet, only a very few exist expressly for shop or classroom use. The most readily available non-instructional materials are intended for audiences such as the home "handyman."

Post Secondary

As in the case of secondary schools, materials for use in post-secondary and technical level occupational education are often an assortment of items collected or authored by an individual instructor or program director. The most comprehensive vocational materials assessed were those available from the training programs of the various maritime academies and the military services.

The continuing education programs identified are primarily concerned with skill training, occupational upgrading, and on-the-job training, and they use a minimum of materials. Federal and state agencies provide literature geared for the specific needs of certain industries. The NOAA supported "Marine Advisory Services" has commercial fishing films which are used for continuing education purposes. The National Marine Fisheries Service, (NMFS), provides nationwide market information for fishermen and retailers. Trade journals of the boating, yachting, and offshore industries, as well as publications like Marine Technology Society Journal, The National Fisherman, and Sea Power (Naval League) are up-to-date sources of information for marine workers anxious to stay abreast of changes in their fields.

From the above discussion of existing marine career programs and materials, it is clear that a rapidly developing trend of student and educator interest in marine fields is being hamstrung by a dearth of systematic career education materials. Many educators are reluctant to mount or expand marine career education programs when there are insufficient curriculum materials to support their efforts. Present materials are scarce, and those that do exist are appropriate for only very limited subjects and groups of students. Curriculum materials have yet to be produced for most of the career education phases, and hence for most of the nation's K-14 students.

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[1] Eighteen clearinghouses located throughout the United States, and now reporting to the National Institute of Education (NIE), collect, screen, index and abstract the report and periodical literature in education and education related fields. The data base covers educational literature published since 1966 and contains all citations published in Research in Education (RIE), and Current Index to Journals in Education (CIJE), the two major printed monthly products of the ERIC system. The ERIC file currently contains records for over 135,000 documents. Approximately 1,000 new reports and 1,500 new journal articles selected from over 500 journals are added monthly into the ERIC files.

In the following examples of ERIC citations, the ED Number indicates that the bibliographical entry is available in hard copy or microfiche from the ERIC Document Reproduction Service (EDRS), P.O. Drawer O, Bethesda, Maryland.

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ED- ED086501
CH- SE016952
TI- ELEMENTARY TEACHER'S RESOURCE MANUAL, LIGHTSHIP
    CHESAPEAKE, 1973-1974.
PD- 74
IS- RIE74MAY
IN- NATIONAL PARK SERVICE (DEPT. OF INTERIOR), WASHINGTON,
    D.C. NATIONAL CAPITAL PARKS.
PR- EDRS PRICE MF-$0.65 HC-$3.29
NO- 72P.
DE- ACTIVITY LEARNING; *ENVIRONMENTAL EDUCATION; *FIELD
    STUDIES
DE- GLOSSARIES; INSTRUCTIONAL MATERIALS; *MARINE BIOLOGY;
    *OCEANOLOGY
DE- *RESOURCE GUIDES; WATER POLLUTION CONTROL; WATER
    RESOURCES
AB- THIS RESOURCE GUIDE WAS WRITTEN TO HELP TEACHERS PRE-
    PAPE STUDENTS FOR A TOUR OF THE LIGHTSHIP CHESAPEAKE
    IN WASHINGTON, D.C. HOWEVER, MUCH OF THE INFORMATION
    WOULD BE USEFUL IN ANY UNIT ON MARINE BIOLOGY AND
    WATER POLLUTION.  A GLOSSARY OF NAUTICAL TERMS IS IN-
    CLUDED AS WELL AS POSSIBLE LABORATORY ASSIGNMENTS AND
    RELATED ACTIVITIES IN SUCH AREAS AS SOCIAL STUDIES,
    LANGUAGE ARTS, AND ARTS AND CRAFTS. (LS)

ED- EJ096758
CH- SE510678
AU- MACKENZIE, W. D. F.
TI- SEALS AND THEIR ADAPTATIONS
PD- DEC 73
SO- SOUTH AUSTRALIAN SCIENCE TEACHERS JOURNAL; 734; 18-24
DE- *BIOLOGICAL SCIENCES; *ECOLOGY; *MARINE BIOLOGY;
    *SCIENCE EDUCATION
DE- ANIMAL BEHAVIOR; BIOLOGY; CLASSIFICATION; ECOLOGICAL
    FACTORS
DE- PHYSIOLOGY
ID- *SEALS
AB- DISCUSSES SEALS IN TERMS OF THEIR CLASSIFICATION, ECO-
    LOGICAL INFLUENCES, THEIR PELAGE, MOULT AND THERMO-
    REGULATION, RESPIRATORY AND VASCULAR SYSTEMS, PREDA-
    TION AND MORTALITY. (JR)
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ED- ED089995
CH- SE017546
AU- MORGAN, MYRA J.
TI- A BIBLIOGRAPHY OF ELEMENTARY AND SECONDARY MARINE
    SCIENCE CURRICULUM PROJECTS AND EDUCATIONAL MATERIALS.
PD- 73
IS- RIE74AUG
IN- RHODE ISLAND UNIV., KINGSTON.
SN- NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (DOC),
    ROCKVILLE MD. NATIONAL SEA GRANT PROGRAM.
PR- DOCUMENT NOT AVAILABLE FROM EDRS.
AV- NATIONAL TECHNICAL INFORMATION SERVICE, 5285 PORT
    ROYAL ROAD, SPRINGFIELD, VIRGINIA 22151 (COM-74-10196,
    PC-$3.00 MF-$1.45)
NO- 26P.; UNIVERSITY OF RHODE ISLAND MARINE BULLETIN NO. 15
DE- *ANNOTATED BIBLIOGRAPHIES; *CURRICULUM; ECOLOGY
DE- ELEMENTARY SCHOOL SCIENCE; *MARINE BIOLOGY; *OCEANOLOGY
DE- *SCIENCE EDUCATION; SCIENCE MATERIALS; SECONDARY SCHOOL
    SCIENCE
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[2] OASIS provides computerized searches of both NOAA and non-NOAA multi-discipline publication reference files and gives the user access to major marine bibliographic information files not available anywhere else in computer-searchable form. OASIS provides over 10 million citations on bibliographic references, abstracts, and indexing terms and is updated monthly.

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CURRENT ISSUES RELATED TO MARINE OCCUPATIONAL PERFORMANCE

The modern world of work increasingly requires each worker to face a number of complex issues affecting his physical, moral and social being. The relevant knowledge base of an occupation, particularly in the cognitive and affective domains, can be separated according to defined sets of issues and concepts. The inclusion of certain physical, moral and social issues in occupational decision making facilitates focusing and sharpening the distinctions that need to be made when designing curriculum materials. For example, issues chiefly concerned with the physical have to do with the impersonal, that is, things or matter, while social issues are chiefly concerned with group or individual behavior in the political and economic realm, that is, the acting out of interpersonal relationship roles.

The distinction that is made between moral and ethical is one of basic codification (more than simply a question of relative degree). For example, when seamen vote work rules, they have defined a code of behavior they expect fellow crew members to observe. In doing so, the seamen have established a set of rules or regulations that can be used to judge peer group behavior. Such canons seldom have the force of law, but they serve as a set of norms for individuals to regulate their personal behavior. An issue affecting a worker can be seen to have a physical, moral or social facet, but more often than not, value judgements must be made by single workers or groups of workers.

Persons who will make careers in the marine field will become aware of value systems which are considerably different from those proclaimed in land based industries. The value system that persists in many marine industries and the occupations common to those industries is based on traditions that are rooted in conservative political and economic philosophies. In spite of the apparent relationship between environmental concerns and marine resources, much current practice is pure "laissez faire".

This observation is not meant to judge the appropriateness of that orientation; but it is essential that efforts to develop new curriculum take into account that which is if students are to be equipped to deal with reality.

Twelve key issues have been identified as the most significant "...physical, social, moral and ethical values and considerations related to marine occupational performance."

- affirmative action for women and minorities
- the exponential growth of technical information
- occupational inflation
- industrial and labor relations
- population impact on the coastal zones
- technological impact on the coastal zones
- resource conservation and development
- pollution control
- expanding energy requirements
- territorial jurisdictions
- world food requirements
- social hostility to long term planning

AFFIRMATIVE ACTION FOR WOMEN AND MINORITIES

The marine field in all of its many facets is dominated by males. Very few minorities occupy key occupational roles and their access to leadership positions is severely limited. The problem is rooted in attitudes, tradition and economics. The changes needed to increase the access of women and minorities to attractive marine occupations will not be achieved only by expanding programs of vocational education. What is required is a comprehensive career education program of K to 14 that provides all persons the experiences they need to make wise career decisions. The approach taken must be designed to reflect actual on-the-job performance requirements rather than traditional folklore. If push button skills are required, one need not be a weight lifter to qualify for that particular job, and if diagnostic capability is essential to on-the-job performance, that can be specified in objective and measurable terms. What is bound to be a far more serious handicap to vocational preparation and placement is the difficulty of defining problem areas that might be described as falling within the great "Marine Mystique". Yachtsmen, seamen, fishermen and similar marine occupations are deeply rooted in the male culture. This situation will only be changed when educators and employers face the problem openly, and when successful programs of affirmative action begin in the early grades and receive adequate planning, cooperation, resources and commitment.

EXPONENTIAL GROWTH OF TECHNICAL INFORMATION

Technology is important because it is the main generating force behind continually improving productivity and growth. Without increases in the rate of productivity, which usually is measured in output per man-hour, there is no gain in an economy's ability to provide goods and services. As a technology becomes more complex, however, the information needed to improve it becomes at each step more detailed and extensive. Productivity then becomes more and more a matter of handling vast quantities of new information in effective and efficient ways. Computers are a good example of a tool society now uses to cope with this problem.

In the marine industries, as well as all American industry, productivity has not increased in recent years. If it is to do so in the future, new ways must be developed for generating, communicating, and utilizing the increased kinds and quantities of information that will permit new innovations leading to higher productivity. At the same time, those entering these industries will need to be better trained so as to be able to use the new information technologies which have been largely neglected in formal school educational programs.

If marine occupational content is to keep up with scientific and technical developments in the marine industries, then better ways must be found to transfer new information to the worker on the job and to students who are preparing to do those jobs. A number of new educational technologies have been developed to help cope with this problem.

OCCUPATIONAL INFLATION

Inflation describes the difference between what a good or service costs and what it contributes. The cost of education has escalated in recent years with no significant improvement in learning achievement.

This is a form of inflation. While less than 20 percent of all job openings in the U.S. require a college degree, an increasing number of persons are attending higher education institutions with the expectation of improving their career prospects. In response, employers have raised their requirements for existing job openings. When these positions are filled by over qualified persons without a corresponding increase in output, the result is occupational inflation.

The Federal courts have interpreted the practice of employers seeking out the most educated as a form of unfair discrimination, and have insisted that educational qualifications and testing of applicants relate to performance requirements of the job. Restrictive trade union practices, unnecessary licensing procedures, or any other device to unfairly restrict entry of otherwise qualified applicants will contribute to occupational inflation.

INDUSTRIAL AND LABOR RELATIONS

Labor relations in the marine industry are diverse and many of the problems are unique. When foreign competition is involved-as in commercial fishing, shipbuilding, and merchant marine-one of the most important issues involves the significant difference between U.S. and foreign industries in regards to wage rates, taxes, insurance, and safety requirements.

Over the past 25 years marine industry-labor relations have changed from turbulence to labor/management maturity. Recently some of the most innovative contributions to improved labor relations have originated with marine industries. An example is the Pacific Maritime Association's mechanization pact with the independent West Coast longshore union.

If marine employment is to continue healthy growth, solutions must be found in other sectors of the marine industries. A climate for fostering this depends on a work force that has been educated to appreciate the contributions employer associations and trade unions have made to American society.

POPULATION IMPACT ON COASTAL ZONES

It is not always possible to identify cause and effect relationships when examining complex issues at a global level. The next five issues are so closely interrelated, it is more useful to focus on what links each issue to the other, rather than to attempt to isolate the specific differences.

Population impact , technology, resource conservation, pollution, and energy requirements are issues that can have grave, interacting consequences on the marine environment. Spaceship earth, like a lifeboat, is capable of a limited number of passengers. It has a life support system containing air and water capable of recycling if it is not over taxed. Man, operating within this vehicle, has to learn how to turn his technological skills to the conservation of resources including the judicious use of energy. The spaceship earth concept was intended for use for men on land but it has the same meaningful message for men at sea. We must learn environmental management skills that conserve resources and control pollution.

Bos-Wash is a term that describes a land corridor 400 miles long and 50 miles wide running from Boston to Washington, D.C. In this limited land mass live more than fifty million Americans or one-fourth of the U.S. population. While a dramatic set of figures, the population impact on coastal zones has far more serious ramifications than density. Three sub-issues are at play: population shifts, growth, and survival of non-working Americans. There is no way the coastal zone can absorb a continuing shift of the U.S. population in the next 25 years at the same rate as the previous 25 years. While economic realities might in the long run reduce the population on the coast, in the nearer term there will be increased social pressure on the marine environment. For example, more and more people will demand access to increasingly crowded beaches, wetlands and all forms of water recreation. This pressure is probably inevitable; even though we might decide as a nation that we wanted to achieve zero population growth, we could not do it in the next 25 years. Births will continue to exceed deaths for the rest of this century. At the same time, longer life spans, early retirements, higher disposable income, and a shorter work week all indicate that the nonworking portion of the population will rise, exacerbating the demand for recreational opportunities. The people who must plan to provide these services must acquire the skill and knowledge to deal with a new social condition.

TECHNOLOGICAL IMPACT ON COASTAL ZONES

Increasing population in the U.S. and around the world has stimulated world-wide demand for goods and services. While the public has taken notice of the need to develop the coastal zones of this country including the Outer Continental Shelf, the fact is that modern industry has been moving into the coastal zones and onto the OCS at a rate faster than the population has shifted to the coast. The technological impact in these zones has had a profound effect. Electric power production, mining, and commercial development are only a few areas in which the impact of industry on the nation's coastline has been felt. The occupation of beach and waterfront property has increased to the extent that in 1975 more than 80 percent of New England's seashore is privately owned.

Since 1965, dredging and filling have destroyed over half a million acres of this country's important fish and wildlife habitats. In 1970, five tons of sand and gravel were extracted for every man, woman and child in the U.S. While only 10 percent of this amount was taken from beneath the water, the percentage of underwater ground extraction is increasing. Improved technology must be developed to select sites and exploit this resource with minimum damage to the ecosystem.

Offshore technology in the second half of the 70's will see the expansion of deep water mineral extraction, construction of deep water super ports such as the Louisiana Offshore Oil Port to accomodate the new fleet of "superships", and new forms of electric power generating facilities that utilize the most advanced ocean engineering and marine technology systems.

RESEARCH,CONSERVATION AND DEVELOPMENT

The continuing rise in personal income in the U.S. and the expansion of the industrial base in other nations of the world add to the demand on a finite resource base. No longer can the United States be certain of foreign sources for our supply of primary resources.

A single example should serve to illustrate what a national policy to conserve resources could mean for marine employment. To move people and cargo by air requires very high consumption of resources since aircraft cost more than any other form of transportation equipment and have the shortest life span. Fuel consumption per pound mile is also the highest. Trucking, both local and interstate, requires a massive network of costly highways and fuel stops, as well as a huge regulatory bureaucracy that adds very little to transportation output and nothing to conservation. Cargo transported by barge and inland waterway consumes less fuel per ton mile, requires the least upkeep of right-of-way, needs the least land space,and utilizes capital equipment that has an operating life span usually in excess of twenty years and often thirty years.

As the nation becomes more aware of the need to conserve resources, it may also rediscover the practicality of water transportation for doing this.

POLLUTION CONTROL

Pollution is the dumping of waste into the natural environment causing an unnatural change. The effects of using sea water to cool man-made energy systems remain a matter of controversey. Chemical pollution is the dumping of foreign elements into natural bodies of water as waste resulting in the alteration of a delicate balance of the water chemistry. Mining, dredging and similar forms of intervention in the marine environment take their toll.

To appreciate the results of marine pollution, it is necessary to understand the two marine environments: fresh and salt water. The oceans cover 70% of the earth's surface and contain 97.2% of all the water. Only .04% of all the water exists as fresh water in lakes, streams and the water table within the top half mile of the surface. (The remaining water is in glaciers, ice caps, saline lakes, the atmosphere, and below one half mile of the surface.) Pollution of fresh water environments destroy our potable water supply. The pollution of salt water environments can be equally harmful since it can lead to possible climatic change and harm marine life including food sources.

EXPANDING ENERGY REQUIREMENTS

Resources are of two types, renewable and exhaustible. Most forms of energy used by modern industrial man are of the exhaustible type. Petroleum, coal and natural gas are all exhaustible resources and the three represent better than 90 percent of the energy sources used in the U.S. Nuclear, geothermal, and hydroelectric are additional sources, with the prospect of solar energy representing a new source for the future.

Energy under the oceans certainly includes coal and geothermal sources, but the present technology is directed at petroleum and natural gas. The continental shelf contains 40 percent of the known U.S. petroleum potential. The OCS and the Alaskan fields represent the only known sources for increasing domestic production. Demand for oil and gas will increase over the next 10 years from 60 quadrillion BTU's per year to at least 80 quadrillion. Of this expanded number, the OCS will provide 16 percent of the oil resources and 20 percent of the natural gas. This adds up to a significant expansion of all offshore activities. The need to increase the supply of oil and gas production from under the sea is recognized, but as of 1975, there is no systematic and national program to develop a supply of trained workers for this critical marine industry.

TERRITORIAL JURISDICTION

Any examination of U.S. territorial jurisdiction must recognize that citizens have major interests on three levels: international, national, and regional. Territorial jurisdiction is essentially a political issue with enormous impact on the economy and military defense. For 200 years of nationhood, the U.S. pursued a policy of freedom of the seas. Over the past 20 years it has had to increasingly assess the national interest in regard to the extension of U.S. coastal jurisdiction. Not all regions of the country, however, agree on a single national policy. For example, fishermen on the West Coast divide into two camps. Those in the Northwest favor a 200 mile extension, while those from Southern California who work the waters of Latin America fear the consequences of an extension. Uncertainty over the consequences of territorial extension has caused Congress to postpone action. The U.S. Navy is fearful that the retaliation they anticipate from many other nations will restrict ship travel in coastal waters of those countries. Many U.S. firms wish to maintain their access to the mineral resources located off the coast of nations that have not declared a 200 mile limit. The impact and complexity of the issue make it a critical concern for all students of marine affairs.

WORLD FOOD REQUIREMENTS

Vast areas of the oceans are virtually deserts. The world's natural fisheries may have already reached their maximum yield while the amount of land suitable for agriculture is shrinking. All of this is happening as the world's population continues to rapidly expand. It may be possible to increase the productivity of the oceans by increasing the fertility of selected areas either by utilizing some of man's wastes or by artificially causing upwelling. We have already lost the opportunity to fully farm the seas, but we still have the opportunity to link agriculture to aquaculture as a new food production system. Yields of one million pounds of shrimp per acre have been achieved in Florida wetlands and experiments in California on the Maine lobster indicate that significant gains are possible from land based seafood farming. Trout and salmon are examples of high market value fish that are successfully raised on land. Perhaps the long-term solution will be found when we learn how to establish a complete food chain that links man into the ecocycle so that a balance is achieved between the various niches in the ecosystem. To achieve this plateau a great deal more research and planning will be required.

SOCIAL HOSTILITY TO PLANNING

There are basic philosophical differences between the "haves" and the "have nots" of the world in their attitudes toward the utilization of ocean resources (total exploitation vs. management for maximum sustainable yields). Some sort of planning is needed to resolve such differences with compromised solutions. However, in the U.S. there is hostility to planning, which to many people implies a threat to the free enterprise system, a trend toward socialism, or at least government interference and regimentation. However, more and more enlightened citizens have come to realize that a certain amount of intelligent planning may make the difference between prosperity in the private sector and economic chaos. A proposal to coordinate economic policy-making functions in a new Office of National Economic Planning has received strong support from various government officials, economists, and union leaders, and may soon be implemented in one form or another. Such a planning office would not, for example, set specific goals for the commercial fishing industry but would indicate the quantity of seafood we are likely to require over time (long-range, short-range) and induce the relevant industries to act accordingly. The choice is not between plan and no plan, but between coherent planning and chaotic planning.

GUIDELINES FOR FUTURE CURRICULUM DEVELOPMENT IN MARINE EDUCATION

The purpose of the final part of this report is to provide a basis for making decisions regarding future curriculum development. Current marine career program offerings, at less than the bacalaureate level, comprise a patchwork of isolated activities. Three major observations about these programs have been reported in earlier parts of this report, and they provide a basis for indicating future need. The three observations were:

(1) Isolated marine education curricula and materials do exist, but only as the result of individual efforts to fill the gap in this field.

(2) There exists no national or regional program of marine career education complete with curricula and appropriate materials.

(3) Based on the current and future manpower projections, the lack of programs and materials, and based on increased student interest in the marine field as well as pressure to develop viable and comprehensive career education programs, this report proposes that the U.S. Office of Education support the development of a comprehensive Marine Education Curriculum effort.

The project study leads to the conclusion that at least four distinct efforts will be required in order to fully develop a comprehensive Marine Education Curriculum. These four elements are:

- a specialized marine occupational analysis
- the specification of appropriate instructional objectives for each phase of the career education process
- systematic development of instructional materials
- coordination at the national level of those agencies having responsibility for marine education and manpower .

The information currently available about student interest and potential careers is sufficient to justify starting the design of curricula for the Awareness and Orientation phases of career education. Similar initiatives can also be made at the next two phases of career education.

NEED FOR AN OCCUPATIONAL ANALYSIS

It will be necessary to identify and obtain more information on marine occupations and their specific job content before final decisions can be made about the design of Exploration and Preparation phase programs and materials. Occupational analysts attempt to describe the following elements when measuring specific occupational content:

- the tasks performed
- frequency of each task performed
- critical level of each task
- conditions under which the task is performed
- accuracy required of each performance

For most occupations, the number of tasks seldom exceeds 250 task performances, and usually the mean is about 150.

> EXAMPLE: A Mate on a merchant ship sends a message to another vessel in international code by use of lights. This general task is one of more than a hundred he will perform in a single day or week on the job.
>
> TASK:
>
> (a) At least two specific tasks are involved: coding the message accurately and sending the message by use of lights.
>
> (b) Frequency. This general task may be routine for some Mates, seldom performed by others, but all ships' officers must be proficient at lights and code as a matter of international maritime law.

(c) Significance. The ability to communicate using this procedure could be judged critical in an emergency or routine, depending on prevailing conditions.

(d) Environment. Conditions, particularly at sea, frequently change. Even with the weather making radio and voice contact uncertain, lights can be used under any conditions.

(e) Criteria. The speed of the sender and his accuracy can be measured in words per minute in sending and receiving.

Educational planners require detailed measures of occupational content when designing instructional programs. Such information provides the basis for developing both programs and materials. When on-the-job task descriptions are available in a form validated by employing industries, a designer of an instructional program can translate on-the-job performance into specific learning objectives. In turn, each of the specified learning objectives may require certain prerequisite learning experiences. In the case cited above, basic Morse Code is a prerequisite to International Code. Basic forms of math are prerequisites to celestial navigation and chart reading may be a prerequisite to simple piloting.

In addition to assessing specific job content and describing this on-the-job performance in behavioral terms, it is recommended that the proposed occupational analysis search out commonalities existing among closely related marine job families. A systematic search of the tasks performed in common by closely related marine occupations will permit programs and materials to build curricula around "common-core competencies". This proposed search can lead to the development of two inventories useful to curriculum designers.

The first inventory will list the knowledge and skill requirements identified as essential to successful on-the-job performance in each marine occupation. This part of the inventory would provide the basis for designing marine instructional materials at all levels, and particularly for programs requiring a common core of information.

The second inventory list will permit curriculum designers to prepare special "marinization units" that can be mastered by individuals already having a skill base or by students enrolled in non-marine occupational training. The marinization units could also facilitate the design of individual learning packages as well as enhance the more traditional program offerings. For example, a student enrolled in automotive mechanics could acquire the skills needed to work safely and efficiently in a marina or boatyard by mastering a set number of "marinization instructional modules". Distributive Education students could seek employment in boat sales or chartering once they completed suitable training in relevant "marinized units".

In the course of program site visits, the study team identified a number of occupational specialities for which task analysis was available, but in every instance the task descriptions were specific to a particular occupation in a particular region of the country. Small engine maintenance and repair in Key West, Florida and salmon fishing in Washington State are examples. The U.S. military, particularly the Marine Unit of the Army Transportation Corps, has undertaken detailed occupation analyses, but substantial modification would be necessary to make this data source useful to career education programs.

Therefore, considerable work remains to be done in measuring both marine occupational content and specific on-the-job performance requirements. There is no marine based occupational data on common core skills. Nevertheless, an adequate information base exists from which one can begin to make curriculum development decisions.

INSTRUCTIONAL OBJECTIVES

The preparation of goals and objectives is a continuous process in curriculum development. As more information becomes available concerning students to be served, and as specific occupational requirements are clarified, it is possible to prepare more precise learning objectives. The goals and objectives to be presented below provide a frame of reference to begin the design of curriculum.

Each of the five major sub-fields of marine employment has unique job requirements, training requirements, working conditions and lifestyle, making it essential that each facet receive adequate attention in the curriculum development process. For example, the Recreation field includes marinas where the work is sometimes seasonal. Commercial fishing, in the Marine Resources sub-field, sometimes requires ten days on the job and four days off. When there are fish, you fish, without consideration of the hour or the weather. An individual involved in coastal zone management, under the Marine Science sub-field and Regulatory/Environmental setting, must have an expertise in human relations as well as estuarine environments. The ship fitter categorized under Shipbuilding in Marine Technology needs training in basic industrial management skills to direct workers, some knowledge of chemistry to understand the properties of the metal involved, and familiarity with marine architecture and engineering in order to translate blueprints into a ship fit for the sea. The worker who crews on a "mudder" delivering drilling materials to offshore oil rigs under Maritime Operations must be able to function in adverse and sometimes dangerous weather conditions, as well as meet Coast Guard certification requirements.

How can a student make a career choice faced with a variety of options available in the Marine Field?

Students must have the opportunity to gain sufficient knowledge about career choices. Concurrently, they must acquire decision-making skills as well as the on-the-job skills required by marine employers. An understanding of one's abilities, aptitudes, interests and personality must be combined with realistic knowledge of a career area. The resulting decision, arrived at over a period of time, prepares the individual to attain success and satisfaction in the world of work.

If students are to make wise career decisions, the process should begin early in the curriculum. One of the initial steps in curriculum development then,is the formulation of goals and specification of learning objectives. Goals are useful in providing direction and can be expressed in general terms. Objectives are more specific and permit accomplishments to be monitored and measured.

A Marine Education Curriculum should include as a minimum the following general program goals:

- Acquaint students with the working world of marine employment as a distinct career field.
- Develop realistic attitudes in students towards marine occupations.

- Familiarize students with operations and functions of marine occupations.
- Show relationships between the variety of marine occupations and different lifestyles of the marine worker.
- Develop decision-making skills for each stage of the career development process.
- Provide for students to acquire entry level marine occupational skills.

In addition to these general goals for the marine career field, more specific objectives are considered applicable to the four distinct phases of the curriculum. Separate curriculum materials need to be developed in order to meet the national need for the marine career programs. Essential to this effort is the vertical articulation of the curriculum. The elements and materials needed to support programs should be based on the objectives of those programs outlined for each phase of the marine career development process.

In order to illustrate how goals and objectives should be applied to these phases, an example set appears below. Following each set of objectives is a brief narrative suggesting possible learning activities. In order to make these suggested activities more relevant to marine careers, the occupation of commercial fisherman is used to illustrate how a person might gain the experience to make this field their choice of careers.

Historically, the commercial fisherman has been a symbol of a young nation's search for food from the sea. As the subject of art - (Winslow Homer's Shipwreck); literature - (Herman Melville's Moby Dick); and music - (Ballad of a Captain's Widow), the hardy, oft-times romanticized fisherman, complete with sou'wester, corncob pipe and squared jaw, strikes a proud and independent chord in many Americans. And yet, what do commercial fishermen actually do? They must endure erratic fish prices, travel out onto the inhospitable sea (aboard a rolling, noisy, drafty vessel, often in need of maintenance) in competition with large, modern and efficient foreign fishing fleets. _If_ lucky enough that fish are coming their way, and _if_ the weather moderates enough to set their gear and bring in the catch, and _if_ the fish are bringing a decent price at the daily fish auction when the boat comes in, then they are able to go home with some money in their pocket to visit their spouse and children for three to four days before they are required to head out again.

How can students be prepared for such a career? How can they develop some basis for making a career decision in any field?

One premise outweighs all others: _a successful career education program should be coordinated and comprehensive in order to prepare an individual for entry into a productive career_.

The outline of goals and objectives, therefore, is intended to provide direction for designing curriculum that can be fully integrated and coordinated with the regular instructional program.

Program Objectives For The Marine Career Curriculum By Phase

Awareness Phase Objectives

- Introduce students to the marine world of work and play.
- Acquaint students with local marine resources.
- Observe marine employment settings.

- Introduce students to marine literature and vocabulary.
- Begin training in prerequisite skills, i.e., swimming, star sighting, map reading, boat safety.

During the Awareness Phase the student learning activities would include visits to local fish markets, commercial fishing wharves and aquaria, as well as other marine field sites. Reading materials would include references to the marine world and the vocabulary unique to that world. Classroom activities might involve simulation games related to the world of the sea as well as an early awareness of the interrelationships of man and the sea. Some prerequisite skills might be taught, such as swimming.

Instructional objectives and appropriate learning activities for the awareness phase could be organized as a separate unit of the curriculum, an integrated unit in an existing course or distinct objectives in a general program of instruction concerned with the world of work.

Orientation Phase Objectives

- Introduce students to the variety of careers found in the marine field.
- Acquaint students with the terminology and literature (both technical and pre-technical) relative to particular marine industries and occupations.
- Show the relationships of student aptitude, interests and values to careers in the marine field.
- Orient students to the economic significance of the marine industry to the local, state and regional economies.
- Equip students with basic career decision-making skills.

The Orientation Phase would involve a higher degree of sophistication by learners. Students would be introduced to the purposes and functions of marine employment settings. The social, economic, and political considerations uniquely related to the marine fields could provide an orientation to this part of the world of work. Students would learn the terminology of the marine world, both through literature and through site visits to a wide variety of marine establishments. Visits and class materials would emphasize the five major sub-fields and the nineteen employment settings of the Marine Career cluster. The interrelationship between the marine world and other school subjects would heighten the student's appreciation and curiosity. Orientation experiences would establish the relationship of student aptitude, interests and values to careers in the marine field. Basic skill development in career decision-making would be a major component in this phase. The use of audio-visual materials would supplement field trips and classroom activities. An introduction to fisheries management and food resource development would further inform the student interested in a particular employment setting, for example, commercial fishing.

Exploration Phase Objectives

- Acquaint students with the purposes and functions of marine occupations.
- Provide hands on experience with tool materials and techniques in relevant occupations.
- Increase the relevancy of school subjects to occupational skills in the marine fields.
- Give students in-depth exploration of the major job groups within the marine occupations family.
- Provide students through basic course content, learning activities, work observation and other exploration experience a basis for making tentative choices among marine occupations.

- Establish relationships of the marine field with the social, political and geographic development of the nation.
- Develop career decision-making skills.

The Exploration Phase moves from a general marine employment setting and begins to focus on broadly defined occupational families. Therefore, this phase must provide the student realistic and detailed knowledge about the work demands, lifestyle and training requirements necessary to enter an occupational family such as commercial fishing. Work simulation and hands on experience is introduced in the exploration phase. Field work experiences and observations would complement classroom activities and materials to allow the student to make tentative career choices in the marine field. To relate these objectives to commercial fishing, the following learning activities could apply. A day at a fish processing plant helping unload a trawler is a primary source experience. A day trip on a floating lab or similar all day trip on a boat would capture some of the demands of the fisherman's lifestyle. It would also provide a test for seasickness. Classroom activities would center on defining the job of a fisherman. What kinds of fishermen are there? What different kinds of fishing boats and gear? How do you get on a boat? Once on, then what? What about pay? Sick leave? Family life? Now, the student has tentatively decided, based on his best information and experiences and the guidance of others, that the student wants to be a commercial fisherman.

Preparation Phase Objectives

- Prepare students for entry-level employment in marine occupational job groups.
- Equip students with a "common-core" of skills, attitudes, and competencies for success in marine occupational family.

- Enable students through both classroom and work experience opportunities to make realistic decisions about work in a relevant marine occupational family.
- Maintain proficiency in marine occupations to meet advances in technology.

The Preparation Phase is designed to enable a student, through both in school and on-the-job work experiences, to make realistic decisions about employment in a particular marine occupation. More extensive field experience should be involved. A ten day trip as crew on a fishing trawler will reinforce the need to learn certain skills in line handling, net repair, refrigeration, diesel engine repair, hydraulic and electrical systems,and the like. Classroom activities should help prepare the student for entry level work in that field. A "common-core" of skills, attitudes and competencies will equip the student for success in the field. These might include the history of National Fisheries Policy as well as line splicing. Also involved might be a study of the merchandising of fish from fishing boat to the consumer as well as the theory of hydraulic mechanics and other specific occupational skills. The Preparation Phase should result in a well-informed, entry-level skilled individual who understands the particular demands of the work and lifestyle of a commercial fisherman and who can become a productive addition to a fishing trawler crew.

The commercial fisherman was used for purposes of relating instructional objectives to a specific occupation. In selecting other occupations and other marine career fields, different learning activities would be used to meet the same set of general objectives for each phase of the career development process.

SYSTEMATIC DEVELOPMENT OF MATERIALS AND ACTIVITIES

In order to achieve the goals and objectives appropriate to each phase of Marine Career Education, there must be a viable curriculum existing of suitable instructional materials and related learning activities. Both elements must be well planned, developed, and field tested if the Curriculum is to be effective.

Marine instructional content should be derived from two principal sources:

1. Information about occupations and their education and performance requirements;
2. Information about key issues in marine affairs which relate to occupational performance.

Occupational information is the knowledge core of such materials. The issues serve as a bridge by which this core knowledge is linked to other subjects and concerns encountered by the student.

Instructional content must be adapted to meet particular student learning needs, program objectives, and grade level. This material is implemented by related learning activities. Since these activities ideally are custom-tailored to fit specific course content to particular student needs, they normally are defined and planned only after the specific subject content and the particular learning audience have been identified.

Systematic means are needed for identifying and adapting both content and activities to fit each career education phase and each major set of student learning needs. The Marine Careers Project suggests at least two complementary means for doing this: 1) a Topicon, to map the relationships between content items, and 2) a network of interagency coordination to facilitate valid information and learning activities.

The Marine Topicon

The abundance and variety of information and data collected during the course of the project created a problem of classification and retrieval. The solution to this problem was the development of an indexing file to permit systematic storage and ease of access. Major topics, those most often cited in the documents examined, became the organizational headings and four file cabinets of materials were indexed accordingly.

As the volume of documents increased, it became necessary to modify the index to allow the cross classification of information relative to 19 broad employment settings, 15 occupational families and the key issues affecting the marine environment. A taxonomy began to emerge with certain logical distinctions of importance. Sub-topics, concepts, subconcepts, and specific or specialized terms were identified which allowed the project staff to rank terms, ideas, skills and knowledge by order of understanding or importance. It was readily apparent that such a topic-concept list (Topicon) had application beyond simply organizing a file cabinet.

A pilot Topicon has been developed to trial test the idea. The five levels outlined below provided the framework to produce a list that broke out (to the fourth level) over one thousand headings in this pilot effort:

1. General topics representing the most comprehensive term used to describe a body of relevant knowledge. Example: Marine Engineering.

2. Major topics, concepts or performances. Example: Marine Engineering: Diesel Engine.

3. Intermediate level information that is usually a part of a major concept. Example: Marine Engineering, Diesel Engine, Operating Principles.

4. Minor concepts or terms that describe specific information. Example: Marine Engineering, Diesel Engine, Operating Principles, two cycle engine.

5. Micro terms that specify tasks or highly detailed information skills or words. Example: Marine Engineering, Diesel Engine, Operating Principles, two cycle engine, specific engine part, e.g., fuel injector.

The utility of such a framework is increased by the fact that each level of the taxonomy can serve as the basis for the development of related materials. In addition, the Topicon can be used as a resource reference designed for each level of the marine education curricula, thus making available to educators, in a manageable format, the considerable information and material not specifically designed for instructional purposes.

The Topicon proved to be a useful tool for organizing information so that individual topics and concepts can be related to one another and to other subjects. If the potential of this tool is to be realized, considerable expertise must be involved in fleshing out the information to be contained in the document. This expertise must be recruited from a variety of sources; witness the diversity of the 19 employment settings in the manpower section of this report.

COORDINATION AT THE NATIONAL LEVELS

Owing to the breadth and complexity of the marine field, a comprehensive program of career education can be developed only through full cooperation between key federal agencies exercising responsibility for education and marine affairs. This report, for example, could not have been compiled without the generous assistance of many persons from a wide variety of agencies and industries. These separate resources together can form a coordination network. The National Institute of Education and the Manpower Administration of the U.S. Department of Labor should be included in such a network as major forces in directing education and training toward national manpower needs. The National Advisory Council on Oceans and Atmosphere can provide the proposed network a comprehensive view of all segments of marine affairs. Two units in the National Oceanic and Atmospheric Administration (NOAA) essential to coordination are the Office of Plans and Program Coordination and the Sea Grant Program. These organizations represent only a portion of the total federal effort in education, manpower and marine affairs. Therefore, it is important that at least some linkages to other programs also be established. Perhaps the best way to do this will be to include in a coordination network selected members and staff of Congressional committees having responsibility for various significant marine-related programs. In addition, the valuable role of trade associations and trade unions can not be overlooked. Both have a vital role in advancing their legitimate interest. Industry advisory committees have proved to be a major and positive influence in assisting education to develop relevant instructional programs.

SUMMARY AND RECOMMENDATIONS

Demonstrated current and projected employment opportunity, when combined with student interest, makes a marine occupational cluster a viable field for which to develop a career education curriculum. Since the goals and objectives of marine education readily complement much of the existing curriculum already in place in the nation's schools, the introduction of quality marine career education is likely to support rather than disrupt current programs. Many of the key social, economic, and political issues central to the marine field can be used for the enrichment of social studies units currently offered in the elementary grades. Instructional objectives concerned with career orientation and exploration can be used to make math and science in the middle grades more relevant. At the secondary and post high school levels, marine occupational preparation programs can be implemented as either major or minor courses of study. Also, special "marinization units" can build upon and contribute to traditional programs of vocational education.

With additional research in occupational analysis, the marine field will lend itself to the design of instructional programs based on "common core competencies". The potential inherent in this core approach to curriculum development has not been realized in past years simply because the data base has not been adequate for designing such instructional programs. However, recent advances in the use of computers in searching out the commonalities that exist among families of occupations now makes it possible to assemble this data base. Therefore, the development of comprehensive and integrated Marine Career Education curricula need not wait. The key issues that have been identified provide an initial basis for developing more comprehensive instructional materials. The marine Topicon is a potential tool to facilitate the coordinated development of a comprehensive K-14 Marine Career Education curriculum.

If the potential of Marine Career Education is to be fulfilled, the U.S. Office of Education should:

- UNDERTAKE A DETAILED ANALYSIS OF APPROXIMATELY 200 MARINE OCCUPATIONS LEADING TO THE IDENTIFICATION OF THE SKILLS, KNOWLEDGE AND ATTITUDES COMMON TO ALL MARINE OCCUPATIONAL FAMILIES.
- DEVELOP SEPARATE, ARTICULATED CURRICULUM MATERIAL FOR INSTRUCTIONAL PROGRAMS FOR THE FOLLOWING PHASES OF CAREER EDUCATION:

  Awareness programs to acquaint students with the working world of marine careers complementing existing units of social studies and language arts, or other existing and relevant subjects.

  Orientation programs to examine the five sub-fields of marine employment and adapt mathematics, science, and related instruction for use in the marine environment.

  Exploration programs to provide for initial hands-on learning experiences in a variety of marine occupational families. These instructional units should be of different types and lengths, providing for experience using tools, materials, and technqiues commonly used in marine occupations.

  Preparation level curricula to be utilized in two dimensions:

  1. one, two and three year instructional programs in selected marine occupations;
  2. short term (8 to 16 weeks) special marinization packages to be used in on-going vocational programs in at least the following fields: construction, automotive mechanics, metal working, Distributive Education, electricity, electronics and agriculture.

- DEVELOP A COMPLETE MARINE TOPICON TO PROVIDE FOR THE SYSTEMATIC IDENTIFICATION, STORAGE AND EASY RETRIEVAL OF INFORMATION AND DATA ESSENTIAL TO DEVELOPING MARINE EDUCATION PROGRAMS AND DESIGNING INSTRUCTIONAL MATERIALS.

- PRODUCE GUIDES TO ASSIST IN DEVELOPING NEW MATERIALS. THESE GUIDES SHOULD SUGGEST HOW TO RELATE THE SEPARATE UNITS, PROVIDING FOR VERTICAL AND CROSS-ARTICULATION BETWEEN GRADE LEVELS AND OUT-OF-SCHOOL LEARNING RESOURCES.

- SINCE A TIMELY COMPREHENSIVE PROGRAM OF MARINE EDUCATION CAN ONLY BE DEVELOPED THROUGH A COORDINATED EFFORT AT THE NATIONAL LEVEL BY THOSE KEY FEDERAL AGENCIES CONCERNED WITH MARINE AFFAIRS, THE U.S. OFFICE OF EDUCATION SHOULD PROMOTE THE DEVELOPMENT OF THE RECOMMENDED PROGRAMS AND MATERIALS BY SEEKING THE COOPERATION OF AT LEAST THE FOLLOWING AGENCIES:

  The National Institute of Education

  The Manpower Administration of the U.S. Department of Labor

  The National Advisory Council on Oceans and Atmosphere

  The National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce

    Office of Plans and Program Coordination
    National Sea Grant Program

  And selected staff of the appropriate Congressional committees.

PRIORITIES FOR ACTION

This report has made five recommendations calling for the support of the U.S. Office of Education. Two of these are of the greatest urgency. As soon as possible, the U.S. Office of Education should:

1. Establish interagency coordination for the development of Marine Career Education.
2. Sponsor a comprehensive marine occupational analysis.

These actions are necessary in order to effectively meet the next priority, which is the need for curriculum materials and activities. The most urgent need is at the Exploration phase, followed by Preparation, Awareness, and Orientation, in that order. The proposed Topicon and implementation guides should follow naturally from development of the basic curriculum units.

LIST OF APPENDICES

1. Selected Trade Associations and Major Sub-field Relationships.

2. Selected Federal Agencies Concerned with Marine Affairs.

3. Glossary.

SELECTED TRADE ASSOCIATIONS AND MAJOR SUB-FIELD RELATIONSHIPS

	A	B	C	D	E
AFL-CIO Maritime Committee 100 Indiana Ave., N.W. Washington, D.C.					x
AFL-CIO Maritime Trades 815 16th St., N.W. Washington, D.C.					x
American Association of Zoological Parks and Aquariums Oglebay Park Wheeling, W. Virginia 26003	x	x			
American Association of Port Authorities 1612 K Street, N.W. Washington, D.C.					x
American Boat and Yacht Council, Inc. 15 E 26th Street Room 1603 New York, New York	x	x	x		
American Boat Builders and Repairers Association 2488 Grand Concourse Bronx, New York	x	x	x		
American Cetacean Society 4725 Lincoln Boulevard Marina Del Ray, CA 90921	x	x	x		
American Fisheries Society 1319 8th Street, N.W. Washington, D.C.	x	x	x		
American Fishing Tackling Association 20 N. Wacker, Suite 2014 Chicago, Illinois 60606	x				
American Geological Institute 2201 M Street, N.W. Washington, D.C. 20037		x	x	x	

A. Marine Recreation
B. Marine Science
C. Marine Resources
D. Marine Technology
E. Maritime Operations

	A	B	C	D	E
American Geophysical Union 1707 L Street, N.W. Washington, D.C.		x	x	x	
American Institute Biological Sciences 3900 Wisconsin Ave., N.W. Washington, D.C.		x	x		
American Institute of Merchant Shipping 1625 K Street, N.W. Suite 1000 Washington, D.C.				x	x
American Maritime Association 17 Battery Place New York, New York				x	x
Associated Maritime Officers 17 Battery Place New York, New York					x
American Meteorological Society 45 Beacon Street Boston, MA 02115		x			x
American Oceanographic Organization 777 14th St., N.W. Washington, D.C.		x	x	x	x
American Petroleum Institute 1801 K Street, N.W. Washington, D.C.		x	x		
American Society of Limnology and Oceanography Institute of Ecology University of California at Davis Davis, CA		x	x	x	x
American Society of Naval Engineers 1012 14th Street, N.W. Suite 807 Washington, D.C.				x	
American Society of Oceanography 906 C and I Building Houston, Texas		x	x	x	x

	A	B	C	D	E
American Waterways Operators, Inc. 1600 Wilson, Suite 1101 Arlington, VA					x
Boating Industry Association 401 North Michigan Avenue Chicago, Illinois	x	x			
Bureau of Outdoor Recreation Department of Interior 18th and C, N.W. Washington, D.C.	x	x			
Citizens Committee on Natural Resources 1346 Connecticut, N.W. Washington, D.C.	x	x	x	x	x
Council of American Master Mariners, Inc. 80 Broadway New York, New York					x
Defenders of Wildlife 2000 N Street, N.W. Washington, D.C.	x	x	x	x	x
Federation of American Controlled Shipping 910 16th St., N.W. Suite 302 Washington, D.C.					x
Fleet Reserve Association 1303 New Hampshire Ave., N.W. Washington, D.C.					x
Great Lakes Carriers Association 614 Superior Ave. Cleveland, Ohio					x
Great Lakes Ship Owners Association 2000 K St., N.W. Washington, D.C.					x
Independent Petroleum Association of America 1101 16th St., N.W. Washington, D.C.		x	x	x	x

	A	B	C	D	E
Industrial Union of Marine Shipbuilding Workers of America 1126 16th Street, N.W. Washington, D.C.				x	
Institute of Navigation 815 15th St., N.W. Washington, D.C.					x
International Brotherhood of Boiler Makers, Iron Ship Builders, Forgers and Helpers 400 1st St., N.W. Washington, D.C.				x	
International Longshoreman's Union 17 Battery Place New York, New York					x
International Oceanographic Foundation (IOF) 10 Rickenbacker Causeway Miami, Florida 33149	x	x	x	x	x
International Organization of Masters, Mates, and Pilots 39 Broadway New York, New York 10006					x
Labor Management Maritime Commission 1100 Independence Ave., Washington, D.C.					x
Marine Retailers Association of America 401 N. Michigan Ave. Chicago, Illinois	x				
Marine Shipbuilding Workers of America 1126 16th St., N.W. Washington, D.C.				x	
Marine Society City of New York 80 Broadway New York, New York	x	x	x	x	x
Marine Towing and Transportation Employers Association 17 Battery Place New York, New York					x

	A	B	C	D	E
Marine Technology Society 1730 M Street, N.W. Washington, D.C.	x	x	x	x	x
Massachusetts Marine Educators Association New England Aquarium Boston, MA	x	x	x	x	x
Metropolitan Marine Maintenance Contractors Association Inc. 40 Rector Street New York, New York				x	x
National Academy of Sciences Commission on Oceanography 2201 Constitution Ave., N.W. Washington, D.C.	x	x	x	x	x
National Association of Engine and Boat Manufacturers 666 3rd Ave. New York, New York	x	x	x		
National Association of Fleet Administrators 60 East 42nd Street New York, New York					x
National Association of Marine Services, Inc. 17509 Lafayette Drive Lahill, VA	x	x	x	x	x
National Association Marine Surveyors, Inc. Box 55 Peck Slip Station New York, New York 10038	x				x
National Association of State Boating Law Administrators 2000 B Street, N.W. Washington, D.C.	x	x	x	x	x
National Fishmeal & Oil Association 1730 Pennsylvania Ave., N.W. Washington, D.C.		x	x		
National Marine Distributers Association 2017 Walnut Street Philadelphia, PA 19103		x	x		

	A	B	C	D	E
National Maritime Engineer's Beneficial Association 400 I St., N.W. Washington, D.C.				x	
National Ocean Industries Association Suite 410, 100 17th Street, N.W. Washington, D.C.	x	x	x	x	x
National Oceanography Association 1900 L St., N.W. Washington, D.C. 20036	x	x	x	x	x
National Ocean Survey 6001 Executive Blvd Building 1 Rockville, Md.	x	x	x	x	x
National Park Services Department of Interior 18th and C, N.W. Washington, D.C.	x	x	x	x	x
National Rivers and Harbours Conference 1730 17th Street, N.W. Washington, D.C.	x	x	x	x	x
National Water Resources Association National Press Building Washington, D.C.	x	x	x	x	x
National Waterways Conference Inc. 1730 17th Street, N.W. Washington, D.C.	x	x	x	x	x
Navy League of United States 818 18th St., N.W. Washington, D.C.	x	x	x	x	x
Ocean Industries Association 1100 17th Street, N.W. Washington, D.C.	x	x	x	x	x
Propeller Club of United States 1730 M Street, N.W. Suite 413 Washington, D.C.	x	x			

	A	B	C	D	E
Rachel Carson Trust for Living Environment 8940 Jones Mill Road Chevy Chase, MD	x	x	x	x	x
Radio Technical Commission on Marine Services 1229 20th Street, N.W. Washington, D.C.	x	x	x	x	x
Seafarers International Union 660 Madison Ave. New York, New York					x
Shipbuilders Council of America 600 New Hampshire Ave., N.W. Washington, D.C.				x	
Society of Naval Architects and Marine Engineers 74 Trinity Place New York, New York				x	x
Sport Fishing Institute 608 13th Street, N.W. Washington, D.C.	x				
The Fisheries Council 118 South Street New York, New York	x	x	x		
Transportation Institute 923 15th St., N.W. Washington, D.C.	x				x
Transportation Association of America 1100 17th Street, N.W. Washington, D.C.	x				x
Undersea Medical Society 9650 Rockville Pike Bethesda, MS		x	x		
United Seafood Workers Union 140 Beekman Street New York, New York			x		
Water Pollution Control Federation 3900 Wisconsin Ave., N.W. Washington, D.C.	x	x	x	x	x

	A	B	C	D	E
Water Resources Congress 1130 17th Street, N.W. Washington, D.C.	x	x	x	x	x
Water Transport Association 60 East 42nd St. New York, New York	x				x
Yacht Architects and Brokers Association, Inc. P.O. Box 121 New Canaan, CT	x			x	

SELECTED FEDERAL AGENCIES
CONCERNED WITH MARINE AFFAIRS

DEPARTMENT OF COMMERCE

MARITIME ADMINISTRATION

NATIONAL OCEAN & ATMOSPHERIC ADMINISTRATION

- Environmental Data Service
- Environmental Satellite Service
- NOAA Corps
- Office of Coastal Zone Management
- Office of Sea Grant
- National Marine Fisheries Service
- National Ocean Survey

DEPARTMENT OF DEFENSE

U.S. ARMY

- Army Corps of Engineers

NAVY DEPARTMENT

- Naval Oceanographic Office
- Office of Naval Research

DEPARTMENT OF INTERIOR

- BUREAU OF LAND MANAGEMENT
- BUREAU OF MINES
- BUREAU OF OUTDOOR RECREATION
- BUREAU OF RECLAMATION
- BUREAU OF SPORT FISHERIES & WILDLIFE
- GEOLOGICAL SURVEY
- NATIONAL PARKS SERVICE
- OFFICE OF SALINE WATER
- OFFICE OF WATER TECHNOLOGY

DEPARTMENT OF TRANSPORTATION

- ST. LAWRENCE SEAWAY
- UNITED STATES COAST GUARD

ENERGY RESEARCH & DEVELOPMENT

ENVIRONMENTAL PROTECTION AGENCY

FEDERAL MARITIME COMMISSION

NATIONAL AERONAUTICS & SPACE ADMINISTRATION

NATIONAL ACADEMY OF SCIENCE

NATIONAL SCIENCE FOUNDATION

GLOSSARY

Articulation--The relationships between educational programs which are designed to provide a smooth and meaningful transition for the student from one phase of a program to another.

Awareness--Earliest career education phase. The student is introduced to the world of work: it's value systems, vocabulary, literature, places of employment and prerequisite skills.

Career--Includes all of the experiences, formal and informal, paid employment or leisure time, in or out of school, that add up to and contribute to learning and performing skills with success and satisfaction in a broad field of work.

Career education--A concept of education which brings together both general and vocational education in mutual support to assist the individual in the development and maintenance of a career throughout a working life.

Common core skills--Those skills that when learned can be applicable to more than one occupational specialty and thus provide the learner multiple employment opportunity.

Continuing education--Part-time learning experiences following a period of formal study.

Curricula materials--All instructional resources.

Curriculum--Entire range and choice of resources and program offerings in education.

Decision-making skills--In career education an ability that is developed and based on realistic understanding of job opportunities, job values, skill and knowledge requirements, lifestyle, and wage expectation.

Dictionary of Occupational Titles (DOT)--A classification scheme used for the systematic definition of jobs. The dictionary is published by the U.S. Department of Labor and used extensively by public and private manpower planners and employment counselors. It is generally more detailed than the classification scheme used by the census bureau.

Entry level employment--Those positions accessible to persons having the required skills who are outside the internal labor market.

Exploration--Third phase of career education. Seeks to provide students with career decision-making ability by providing in depth study of selected occupations and hands on experience.

Guidelines--Standards and suggestions providing a basis for decision making.

Hands on experience--One that uses actual equipment normally used on the job; also can mean close simulation of tasks that require the use of tools, materials and procedures as a training method.

Horizontal articulation--Refers to related programs, courses, or activities which exist at any one educational competency level and can provide a coordinated education program for the student.

Marine--For the purposes of this study describes all natural bodies of water and immediate shore lines. Thus the oceans, seas, lakes and rivers are all essential parts of the marine environment, as are wetlands and contiguous coastal bodies.

Marine education--That learning that is designed to impart special knowledge or skill needed to successfully perform tasks that are unique to the marine environment.

Marine education materials--All instructional resources relevant to marine education.

Marine industry--One that has as its primary purpose providing a service or product for use on or under the water or contiguous land bodies (shore lines), and employs workers who have special knowledge and training to successfully perform tasks that are unique to the marine environment.

Marine occupation--Job requiring special knowledge and skill unique to the marine environment.

Marine occupations cluster--A grouping of job functions in the marine environment having a common core of skills and learning which organizes the world of work according to a limited number of unique settings providing a manageable format for young people to view career fields.

Marinization--Modification of vocational program to include marine component--e.g. an auto mechanics course implementing a unit on marine diesel propulsion engines.

Matrix--A structure of cells formed by rows and columns in which variables may be located.

Occupational education--Preparation phase of career education.

Orientation--Second phase of career education emphasizing the purpose and function of specific occupations and the relevancy of school subjects to them.

Post-secondary occupational education--Any post-high school program where employment skills are developed.

Preparation--Fourth phase of career education preparing students through both classroom and work experience for entry-level employment in selected occupations.

Program--A collection of courses or educational experiences sharing a common set of instructional objectives.

Standard Industrial Classification (SIC)--A code for the classification and description of employing establishments by the type of industrial activity in which they are engaged. The SIC is published by the Office of Management and Budget and regularly updated.

Super cargo--Supervisor of all shipboard cargo handling activities.

Topicon--A five-level taxonomy that will list terms, ideas, skills, and knowledge in order of performance from general to specific. The taxonomy levels are: (1) General Topics, (2) Major Topics, (3) Intermediate Information, (4) Minor Concepts, (5) Micro Terms.

Vertical Articulation--Refers to those relationships which exist between institutions, courses, programs or activities and provide a coordinated program for a student moving from one educational competency level to the next.